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CONVENTION ISSUE

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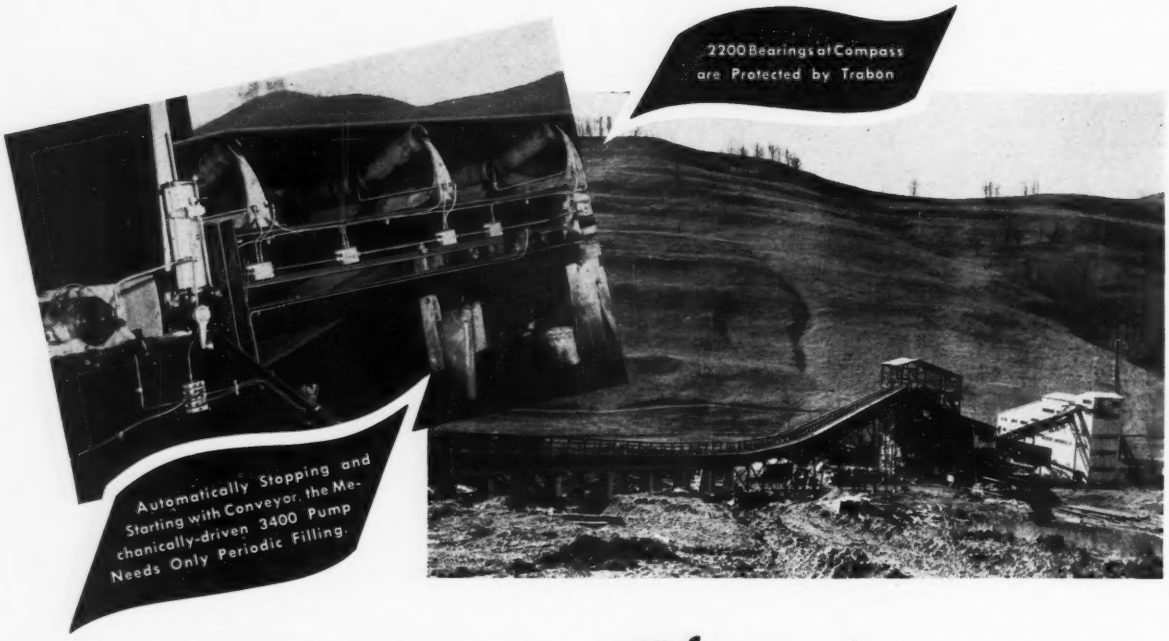
APRIL 11, 12, 13, 1949
HOTEL STATLER (formerly Hotel Pennsylvania)
NEW YORK CITY

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS


2200 Bearings at Compass are Protected by Trabon
Automatically Stopping and Starting with Conveyor, the Mechanically-driven 3400 Pump Needs Only Periodic Filling.

ANOTHER PREPARATION PLANT INSTALLS *Trabon* CENTRALIZED LUBRICATION!

Reduced Maintenance Costs and Better Tonnage Flow at Moss Result in Installation at New Elk Creek Plant.

Clinchfield Coal's new Compass Plant on Elk Creek has a capacity of 7000 tons of sized and washed coal per day. This new tipple and washery located at Overfield, West Virginia, is completely equipped with Automatic and Manual Trabon Centralized Grease Systems on *raw coal conveyors, sizing shaker screens, washers, cones, etc.*

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- ✓ *Trabon Systems are Sealed*—Can be Concealed or Even Buried Under Coal Dust and Grime.
- ✓ *Trabon Has a Single Indicator*—Progressive Feeder Operation Permits Simple, Positive Proof of Lubrication at Pumping Point.

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"LET'S LOOK FOR TROUBLE"

Says
CHIP WRIGHT

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"A plant honing cylinder blocks was considered to be trouble-free when it was averaging 9.6 blocks per stone and getting a fair finish. However, when a change of honing oil made it possible to hone 15.4 blocks per stone and get a better finish, it was realized that there actually had been *trouble* before this profitable change was made.*

"That's what I mean when I say, 'Let's look for trouble.' Another way of stating it is: 'Where can we find opportunity for improvement?' Frequently the biggest single opportunity lies in the choice of cutting fluids."

—Chip

*The change that improved the honing operation cited above was a mixture of ThredKut 99 recommended by a D. A. Stuart Oil Co. representative. ThredKut 99 is easily mixed or blended whenever a special operation calls for its unusual qualities. Ask for a booklet on D. A. Stuart's ThredKut 99 and other time-tested cutting fluids.

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Lubrication ENGINEERING

VOL. 5 APRIL, 1949 NO.

In This Issue

The Editor's Page 63
Authors—1949 Convention Papers 64
Abstracts—1949 Convention Papers 66
Lubrication of Textile Equipment—John R. Crotty 71
The Friction of Dry and Lubricated Surfaces As Determined by the Stick-Slip Method—F. Morgan, M. Muskat and D. W. Reed 75
Significance of Tests and Specifications for Greases—Gus Kaufman 83
National Convention Program—A.S.L.E. 86
A.S.L.E. Lubrication Show, Listing of Exhibitors 88
Current Literature 89
New Products and Equipment 90
News of the Sections 93
Section Officers and Committees 96
Patent Abstracts, Oils and Lubricants 101
Advertisers' Index 108

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343 SOUTH DEARBORN ST., CHICAGO 4, ILL.

BURGESS H. JENNINGS, *Editor*
Northwestern Technological Institute, Evanston, Ill.

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too much Solvent for Oil?

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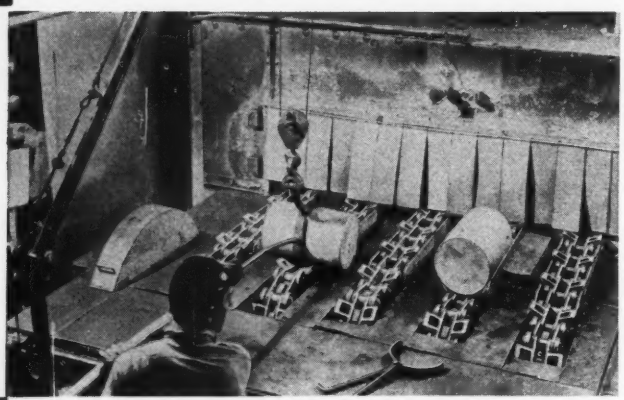
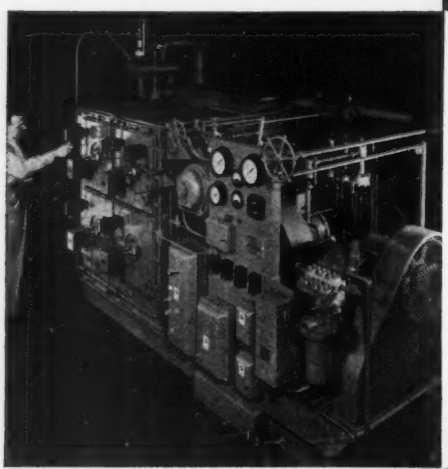


Right—Link-Belt conveyor chains carry aluminum billets for annealing at 900°F. Ideal application for "dag" Colloidal Graphite.



When you can lubricate once a month instead of twice a day, the savings are obvious.

"dag" Colloidal Graphite dispersions often make such savings possible where chemical conditions, rough service, or both extremes of temperature are the foes of easy movement.

Lubricating conveyors, ventilator fans, automatic plating machines, degreaser chains, chills, forging and stamping dies, are among 157 uses we can quote in which **"dag"** Colloidal Graphite has solved vexing maintenance or production problems.

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Right—Degreaser chains for conveying base castings of Hoover vacuum cleaners are lubricated with "dag" Colloidal Graphite.

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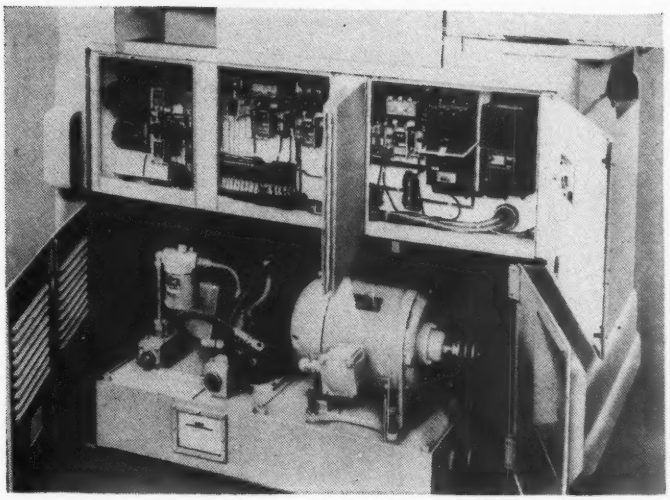

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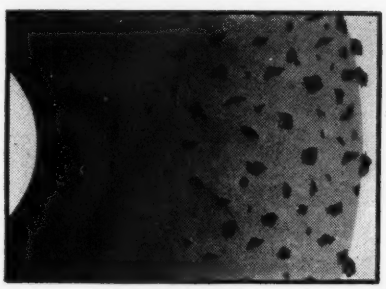

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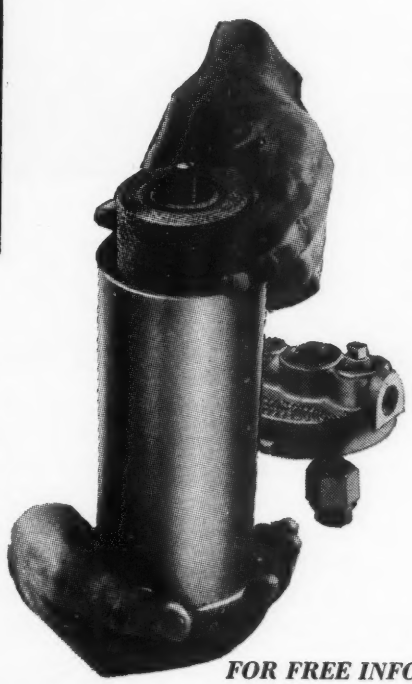

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Cuno MICRO-KLEAN filters come in varying densities . . . capacities from a few to more than 800 gpm . . . connections from ⅜ in. IPS to 6 in. flanged . . . single or multiple cartridges to handle full flow. MICRO-KLEAN cartridges fit other makes; special lengths available for built-in installations.

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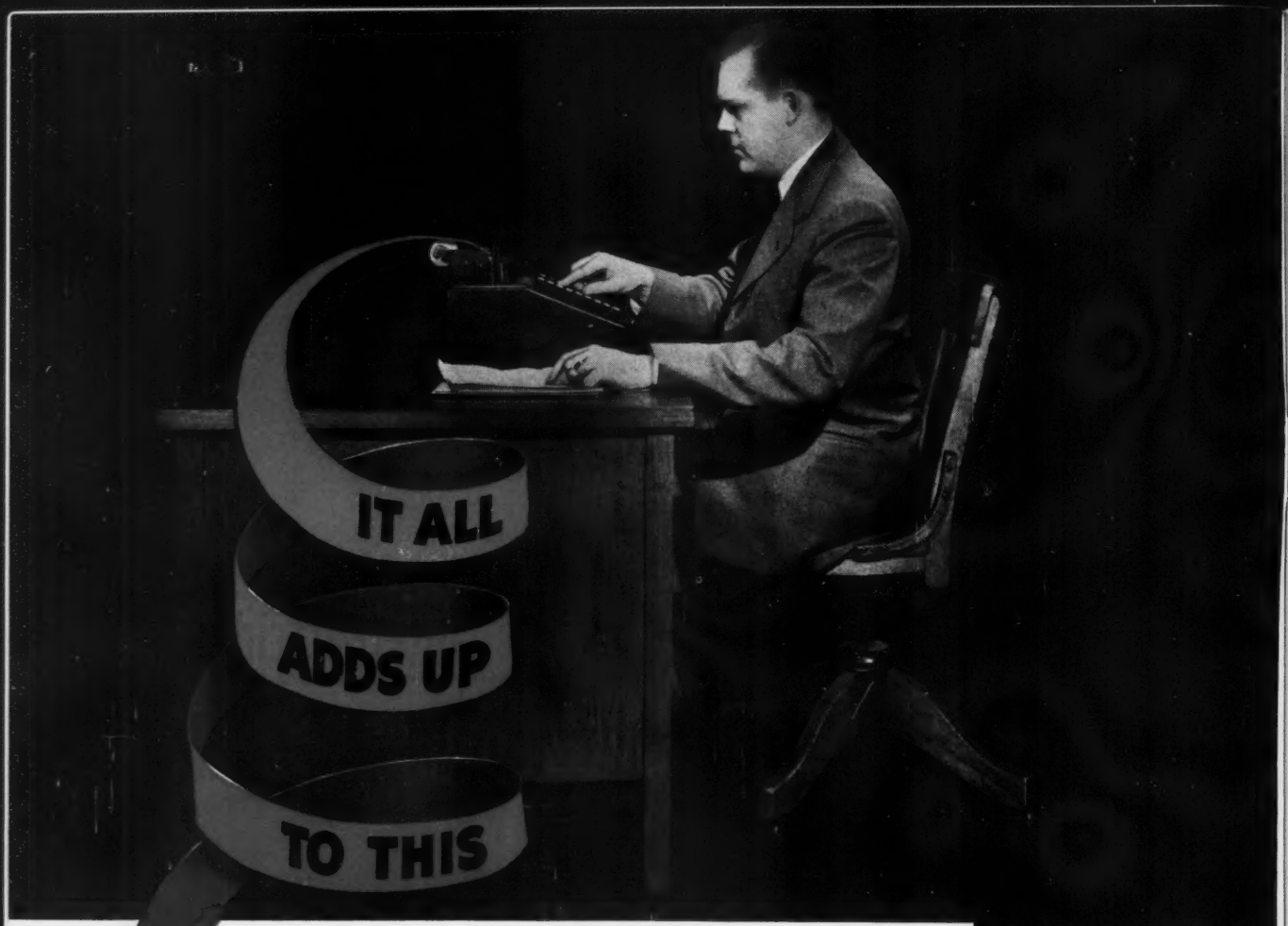

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THE CINCINNATI MILLING MACHINE CO.

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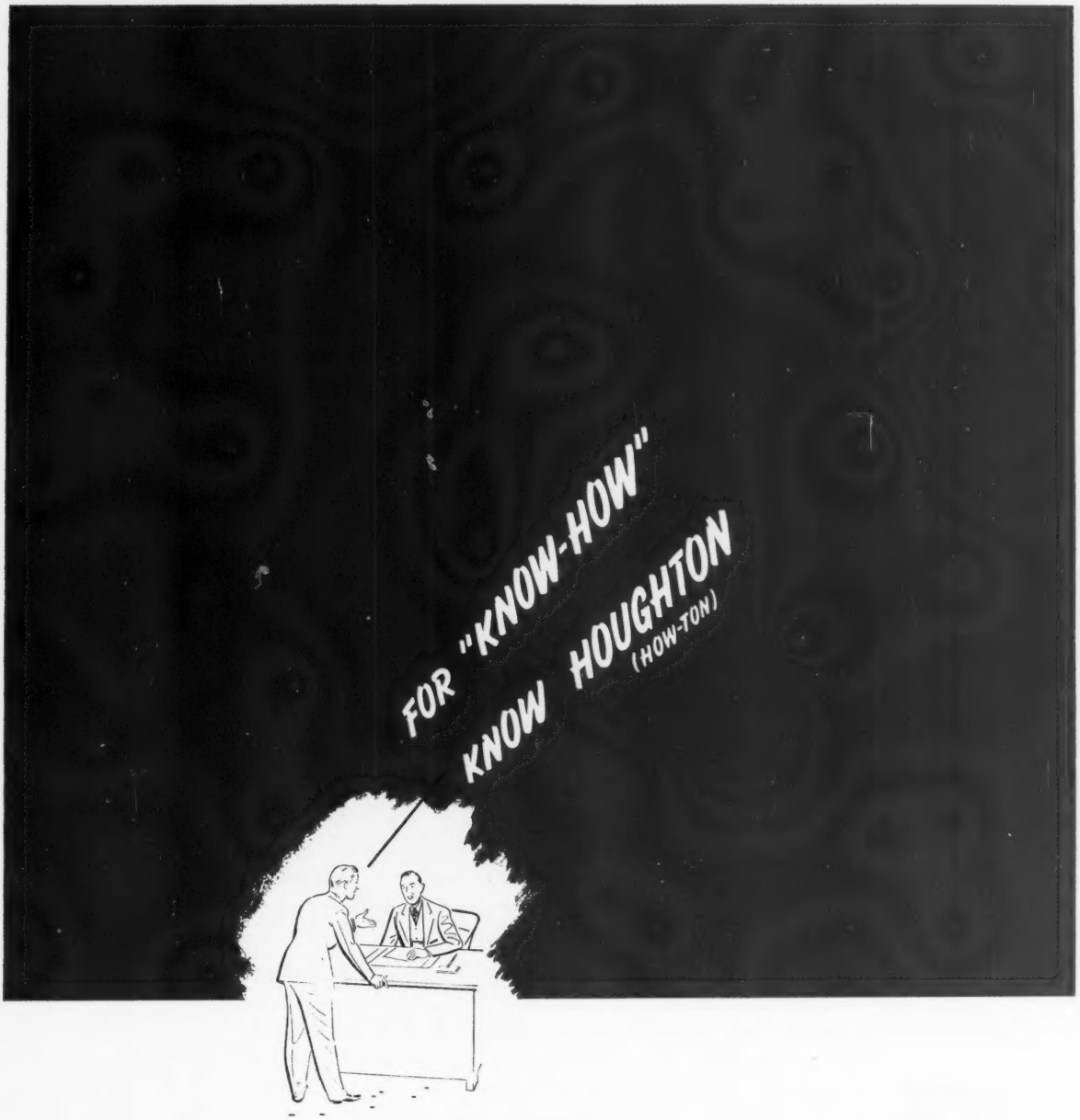

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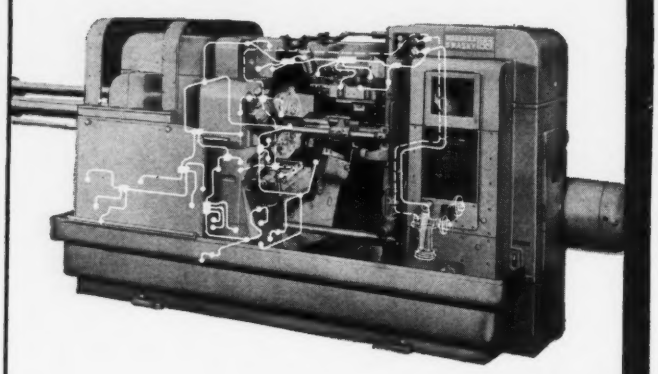

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If lubrication is your problem, why not call on the Bijur engineer, or write for "The Travels of Modern Lubrication." This quarterly bulletin shows how leading manufacturers protect performance and maintain production by using Bijur-lubricated machines.

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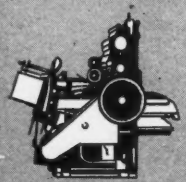

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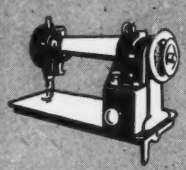

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it's a means to LOWER OPERATING COSTS

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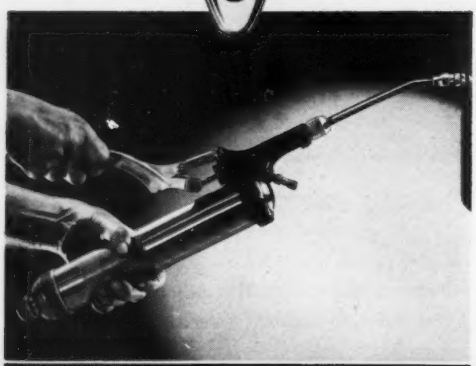

from the simplest manual system

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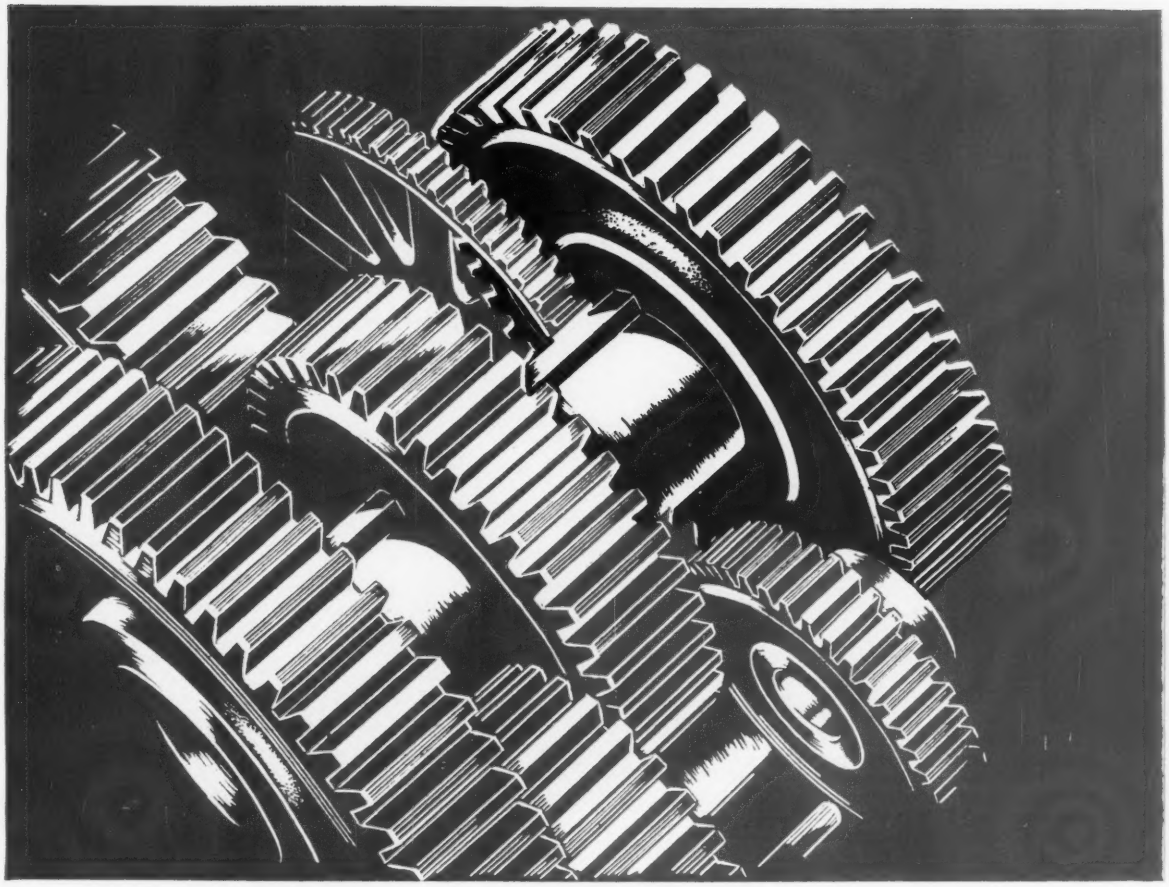

Tycol Engineered Lubrication performs better because:

. . . *Tycol Engineered Lubrication* supplies the scientific answer to every lubricating need in industry—from spindle oils for textile plants to roll neck greases for steel mills.

. . . *Tycol Engineered Lubrication* boosts production by promoting efficient, smoother-running machine operation . . . there's a Tycol oil or grease "engineered" for your specific job.

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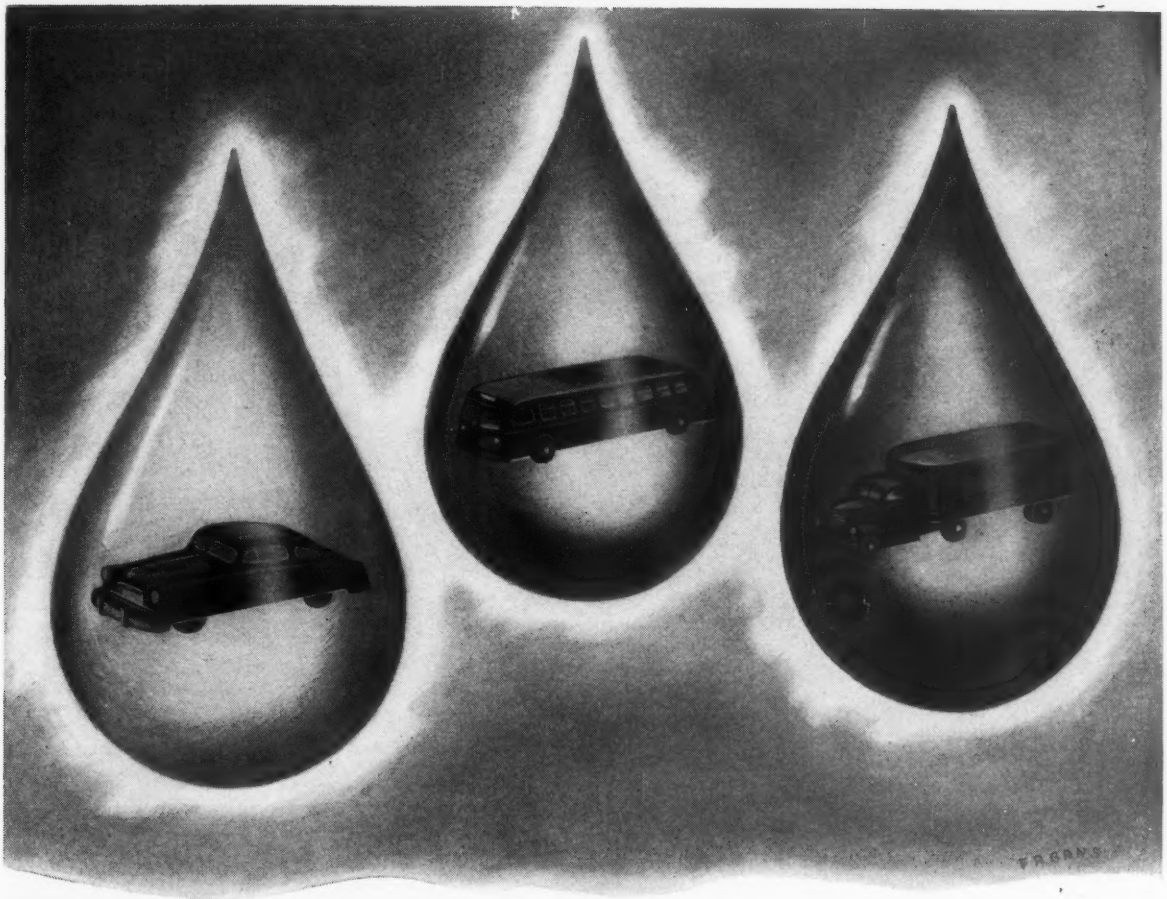

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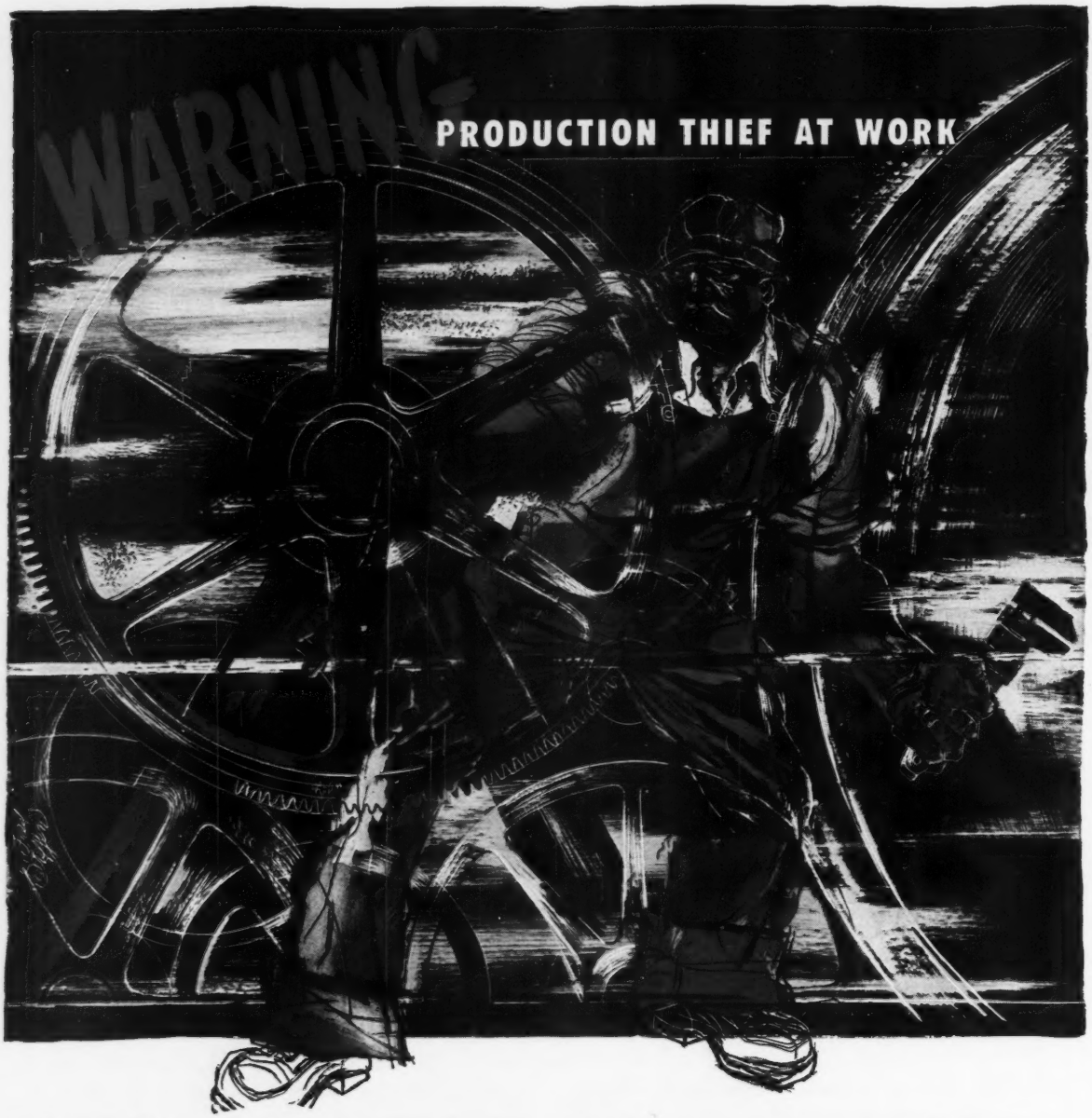

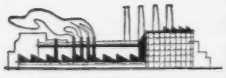

He's a thief of the "sneak" variety—pilfering, robbing, stealing valuable production from machines in thousands of plants. The cost of his thievery is staggering—but he *can* be stopped!

You may not even suspect that he's at work in your plant. You may have to *look* close to find him. But there's a big reward when you do.

For example . . . here are some places to look.

Are you still using the old-fashioned "hand and paddle" method of filling grease guns—wasting time, wasting grease, risking grime and dirt? *There's a thief!*

You can save 3¾ man hours for every 100 lbs. of grease.

Are you lubricating machines the hand and muscle way? *Watch for losses here!*

You can save up to 23.9 man hours in applying each 100 lbs. of grease.

What about "down-time"—production interruptions for lubrication, or for part replacements due to faulty lubrication? *More thievery!*

You can lubricate hundreds of bearings from one central point, with the right amount of lubricant, while machines continue to produce.

Now are you suspicious that a production thief is working in your plant?

His disguise is "old-time, hit-or-miss, costly lubrication methods" that add to the costs of production.

There's one proven way to stop this loss.

An Alemite representative can tell you in 10 minutes how Alemite Methods will simplify and better organize your lubrication procedures. He can show you how mechanized lubrication from barrel-to-bearing will increase your production and profits.

Telephone your Alemite Distributor now. Or write to Alemite, 1847 Diversey Parkway, Chicago 14, Illinois.

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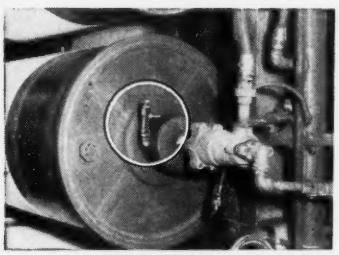
American Product of STEWART WARNER

Silicone News

DC SILICONES

DC 44 Silicone Grease Ends Bearing Failure in Textile Plant

Bearing failure may burn out your motors, stop your entire production line or ruin a mill run. That's why it's front page industrial news when the Plant Manager of the American Finishing Company reports that he has not had a single bearing failure since he started to use Dow Corning Silicone Oils and Greases over 30 months ago.



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DC 44 Silicone Grease in ball bearings on drying cans, operating at 400 r.p.m. around saturated steam journals, has at least 45 times the life of the organic grease previously used.

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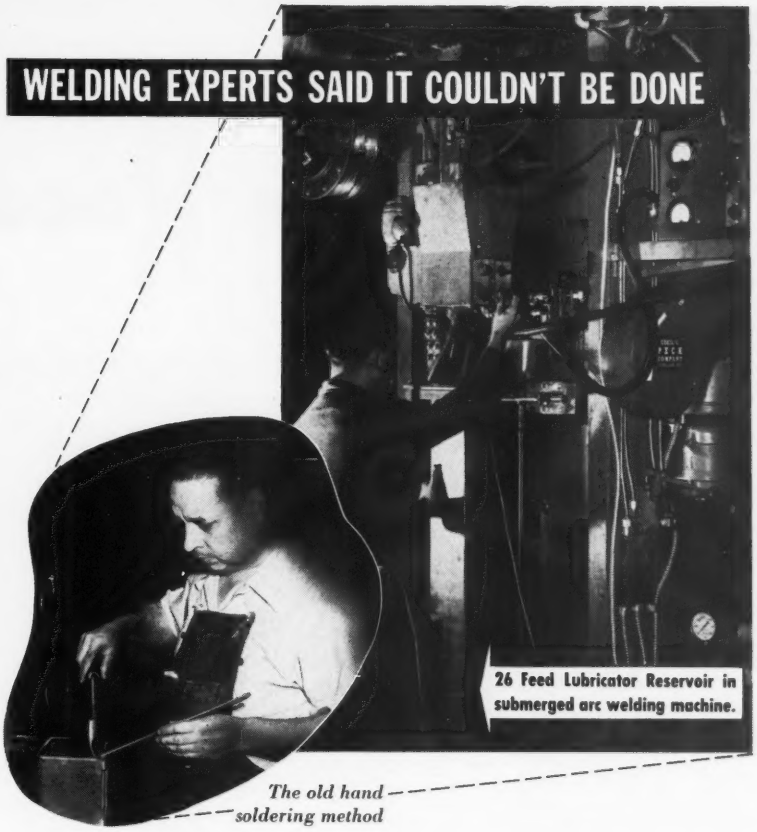

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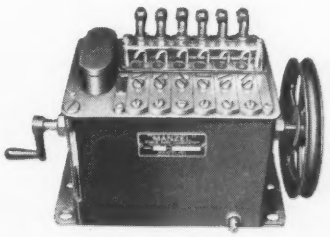

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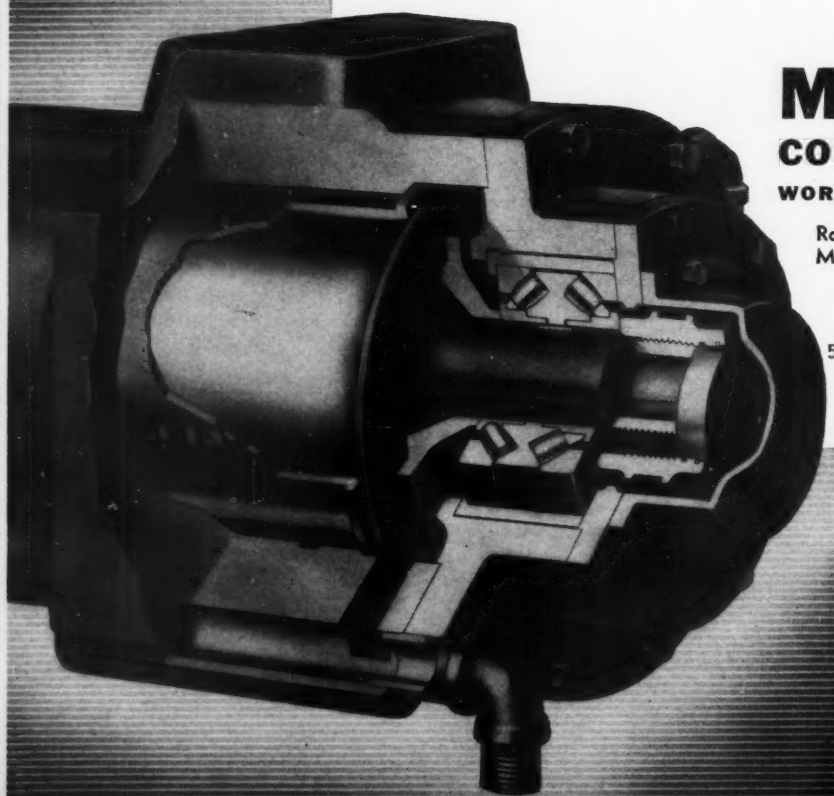

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THE EDITOR'S PAGE

NATURAL GAS—The re-evaluation of fuels in this country over the last few years has placed increased emphasis in the importance of natural gas and brought it into a position of major importance in the fuel picture.

With natural gas, the transmission and the storage problems are of paramount interest. A gas pipe line which can transmit sufficient gas from distant fields to cover normal needs of a community may be highly inadequate during a period of intense demand, such as occurs during a cold snap. Consequently, some means of quantity local storage must be made available with a natural-gas system to carry a community over a peak. It may be of interest to contemplate some of these possibilities.

The gas holder with the movable top is a familiar sight to all of us, and within its limitations has been very successful. Some maintenance is required on the holders for they represent a definite airplane hazard. Unquestionably, these will always be a standard where moderate storage alone is required. An extension of the holder idea was carried out when liquefied gas storage was considered. In this, by storing the gas at low pressures and low temperatures in liquid form, it was possible to make a much smaller size tank suffice for the enormous capacity which would be required if the gas were stored at low pressure in its natural form. The unfortunate explosion and fire in Cleveland, which, incidentally, was not an engineering failure, caused the gas storage development to follow other paths than those of liquid storage. One such path, in an Eastern area, has been the utilization of underground storage of gas in depleted gas fields, adjacent to the point of utilization. Gas from distant points is piped in and pumped into the ground at these relatively convenient spots.

Perhaps the most interesting storage development of all is that of gas storage in pipes under ground, and the recent installation set up near Chicago has attracted nation-wide interest. A pilot storage system was so successful that a 40-million cubic foot storage plant was set up on a 160-acre tract at Mt. Prospect, Illinois. For the system, seamless alloy steel pipe 24 inches in diameter, with approximately ½ inch wall thickness is used. These 40-foot lengths of pipe are drawn in at the ends to form bottle-like cylinders. In each of the rounded ends a 1½-inch pipe-tap opening is threaded and into this the connecting links of 1-inch pipe are made. These, in turn, are tied into a central manifold system. The storage pipes and the connectors are all coated with coal tar pitch and wrapped with asbestos felt to reduce the possibility of corrosion. The system is installed at some 6 feet below ground level and laid in trenches which have been sand filled at pipe level. The gas itself goes through gas compressors which raise its pressure up to 2350 psi. Underground, at a lower constant temperature of some 40 to 50 degrees, the gas cools and the pressure drops to an operating value of some 2240 psi.

It is of interest to know that natural gas has compressibility characteristics widely different from a more perfect gas such as air, a phenomenon known as supercompressibility. In fact, more than 40 percent more natural gas can be compressed into a given volume than is possible with air. The volume of each pipe container is some 110 cubic feet, but under compressed conditions each tank can hold the equivalent of 25,000 cubic feet at the high pressure. It can thus be seen how 40-million cubic feet of gas can be stored under the above-mentioned 160-acre tract of land.

In utilization, the gas at the manifold is dropped from the 2240 psi to the distribution system pressure which varies from 50 to 100 psi. This large pressure reduction has a cooling effect on the gas and it is necessary to warm the gas through a heat exchanger before delivering it into the mains. Underground storage has many advantages, not the least of which is the freedom of the system from atmospheric disturbances, such as storms, lightening and continuing maintenance. If such a system is initially well planned to resist corrosion, it should have an extremely long life without requiring maintenance. Furthermore, its cost for given storage capacity is appreciably less than would be required for large low-pressure storage tanks. It is thought that other communities may follow the same arrangement which has been used in the Chicago area.

DRILLING DEEP FOR OIL—Reports are coming in of more and more deep wells being drilled for oil. Deep wells are those running over 10,000 feet or some two miles. The continuous search for oil is forcing prospecting down to ever greater depths. One well is now in operation which runs to 14,300 feet. In another case, drilling continued to 17,800 feet before the spot was abandoned.

The cost for 10,000 foot wells may run in excess of one quarter of a million dollars.

Those of us who are used to watching power shafts on operating machinery, may realize that the shaft may twist a degree or so in transmitting a heavy torque. The drill pipes for wells twist as much as 8 revolutions in the two-mile length down to the drill bit before the torque is carried into useful cutting action. In spite of cost, wells of 20,000 feet or more seem to be in the realm of possibility in the not too distant future.

BIGGER IN TEXAS—In keeping with its reputation for "bigness," Texas has introduced a new "super." At Dallas, the Alford Refrigerated Warehouses are approaching completion. Nothing in refrigeration approaches them in size. The two buildings are approximately one-third mile long, and cover 22 acres. The refrigerated space is some 7½ million cubic feet and storage space another 8 million cubic feet. Loading, handling and many other innovations have been worked into the design.

Biggest doesn't count alone, but when a lot of *best* goes hand in hand with *biggest,* we have to take off our ten-gallon hats in tribute.

ASLE's exhibition this April, during the coming Convention on the 11th to the 13th at the Hotel Statler in New York, should attract the best in lubrication and be an inspiration for all interested in phases of this field.

For those with international trade interests, the famous Canadian International Trade Fair will be the drawing card in early June. This world famous Fair is held at Toronto and, through its extensive exhibits, has done much and will continue to do much toward breaking down the barriers which impede international trade and progress.

authors of papers fourth ASLE convention

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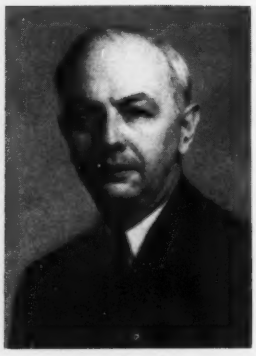
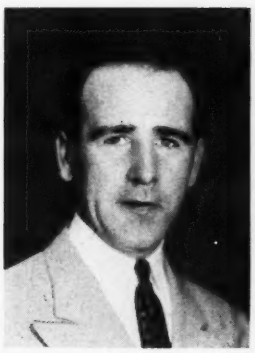


L. W. DEUTSCH



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convention preview

The following abstracts of the papers to be presented at the 1949 Annual Convention of A.S.L.E. are published herewith for general information and to stimulate discussion at the meeting. They do not necessarily represent the final opinion of the authors and are subject to revision when the full papers are formally published.

We express our appreciation to Dr. S. K. Talley for his excellent work in the final editing of the abstracts presented on these pages.

WHAT LUBRICATION MEANS TO MANAGEMENT

BY GRANVILLE M. READ
Chief Engineer of E. I. du Pont de Nemours & Co., Wilmington, Delaware.

Du Pont, like other American manufacturers before the war, furnished several thousand dollars worth of production machinery and equipment for each employee in its plants. The machinery and equipment investment required per employee has doubled or tripled since the war and this company has grown so that the total number of employees now exceeds 70,000. Plants built since the war are considerably more complicated. Profit from this investment depends on a few "mighty midgets." These include skillful design, operating know-how, and *proper lubrication*. You have $2.00 worth of oil and grease in your $2,000 car, but leave that out, the car won't travel far.

In the day of steam engines and water wheels, the oil can and grease bucket got by. Investment per employee was low. Production was made with slow speed machines. The failure of even a main bearing merely meant working extra hours to pick up the lost production. The trend in business today is toward highly mechanized processes, thus requiring proper lubricants and maintenance to avoid machine stoppage. Lost time is more expensive and frequently cannot be made up.

This continuous increase in machine speeds has demanded of the designer that he give proper consideration for its lubrication and prompt and skillful analysis of lubricating troubles when they develop.

Lubrication can no longer be left solely to the "oiler." We must plan and schedule to make certain we get the right lubricant at the right spot at the right time. More important, we must bring skill, experience, techniques, and tools immediately to bear on any lubrication problem that should appear. To the manufacturer, this means having on his staff lubrication engineers fully competent to cooperate with the engineers of the oil companies.

THE ROLE OF CUTTING FLUID AS A LUBRICANT

BY K. E. BISSHOPP,
S'r. Research Engineer, Armour Res. Found'n, Chicago, Ill.
SEVERIN RAYNOR
S'r. Research Engineer, Armour Res. Found'n, Chicago, Ill.
and
ERIC F. LYPE
S'r. Research Engineer, Armour Res. Found'n, Chicago, Ill.

The question of the existence of a continuous fluid fi'm between the tool and chip is controversial. It can be concluded from the results obtained in this paper that a continuous fluid film cannot exist between the tool and chip in the sense considered in the usual lubrication theory. This analysis is based on extrapolated viscosities of various fluids for very high pressures and temperatures in the range where experimental data are not available. These studies show that the viscosities of California oil, carbon dioxide, chlorine and water are of the same order of magnitude at a pressure of 50,000 psi and temperature of 1,000°F. Since a continuous fluid film cannot exist, the cutting fluid may occur in pockets produced by the irregularities of the rubbing surfaces and therefore partial metallic contact between the tool and chip cannot be avoided.

THE DISSIPATION OF FRICTIONAL HEAT

BY H. BLOK
Senior Research Engineer, "Delft" Lab., Royal Dutch/Shell, Delft, Holland.

In many cases the load-carrying capacity of machine parts is decisively affected by the maximum temperatures at the source of frictional heat. In controlling these temperatures, a task which is becoming increasingly important in view of the ever-increasing loads and speeds, two types of dissipation of frictional heat have to be considered.

The first or primary heat-dissipation may be defined as "short distance" dissipation of frictional heat with'n its source and in its immediate vicinity. It is an intrinsic part of lubrication and in boundary lubrication (e.g. EP gear lubrication), the heat-source is constituted by the area of contact and so, the "solid-frictional" heat is primarily conducted away into the rubbing bodies. In hydrodynamic lubrication, the heat-source is constituted by the fluid film and hence the primary dissipation of "viscous-shearing" heat takes place from point to point within the film, and from the fi'm to the bounding surfaces, i.e. the rubbing surfaces.

The second type of heat dissipation or secondary heat-dissipation may he defined as "long distance" dissipation of frictional heat from its source towards some cooling surface (e.g. the outer surface of the housing of the machine part), which, by emitting heat towards the ambient atmosphere, prevents undue accumulation of heat in the machine part as a whole. Secondary heat-dissipation is not typical of lubrication: in principle it does not differ from that in machines embodying heat-sources not created by frictional heat.

The factors entering into the various problems pertaining to the two types of heat-dissipation are discussed at some length, in particular as to their effect upon the maximum temperatures attained. In this discussion, attention is drawn first of all to the primary heat-dissipation, not only because it is often much more crucial than the secondary heat-dissipation, but also because, notwithstanding primary heat-dissipation is most typical of lubrication, it is the least known of the two types.

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SERVICE DEGRADATION AND MAINTENANCE OF PETROLEUM OILS

BY CHARLES J. EGGER
Sales Engineer in charge of Liquid Processing Division, Bowser, Inc., Fort Wayne, Indiana.

Combination of petroleum hydrocarbons with oxygen is by far the most widespread reaction which normally occurs in most service applications. Oxidation of the petroleum oils produces acids of both low and high molecular weight. If water or water vapor comes into contact with the low molecular weight acids, they are extracted from the oil to dissolve in the water. This solution inevitably comes into contact with metalic surfaces and chemical combination takes place and results in corrosion. The higher molecular weight acids and other oxidation products and water withdraw from solution to form an intimate emulsion. This emulsion acts as a nucleus for the deposition of small solid particles such as carbon and metalic oxides, and appears as sludge.

The obvious and perfect solution to the problem would be to refuse to permit the conditions creating it to exist but this is a state of affairs seldom realizable in commercial operations. Consequently more effort is usually directed toward diminution of adverse effects than can be spent profitably in eliminating them. Several objectives seem to be reasonably indicated and may be expressed thus:

The oil selected for a specific application should be as stable and oxidation-resistant as is reasonably possible.

Initial design and conditions of operation should place minimum demands on the lubricant without sacrificing the efficiency of the mechanism.

Means should be provided for the removal of the external agents such as air, water, or other reactants which may be responsible for undesirable chemical changes. By removing these substances as they are introduced into the system, no possibility can arise of the critical concentration being allowed to develop, that is, a concentration in which combination with petroleum hydrocarbons can be initiated.

PREVENTING ACCIDENTS BY PROPER LUBRICATION

BY W. E. MONTGOMERY
Safety Director, Kennetch B. S. Robertson, Limited, Montreal, Canada.

It is a Safety Engineer's job to prevent accidents. To do so efficiently and effectively requires considerable research and investigation of previous occurrences to determine the underlying cause so that they may elsewhere be readily recognized and eliminated before they result in additional loss.

In some of these investigations it was found that the oiler had one of the most hazardous jobs in practically every industry. This was due to the nature of his job which required him to lubricate and service bearings and other equipment that were usually inaccessible, and many times on machinery in full operation.

When a bearing is difficult to service, it many times is neglected to the extent that it is forgotten. Many expensive fires are traced to this condition. Records over a period of years show that 10 fires were caused in the Leather Industry due to over-heated bearings. Paper and Pulp industry was involved in 171 "hot-bearing" fires, 10 fires are charged to the same causes in the plastic industry, and in the Textile industry 287 fires were attributed to over-heated bearings.

Severe internal corrosion of a mine cage rope was listed as the cause of a failure which killed 16 men at the Paymaster Mine. Many other recorded rope failures list the same cause. Proper lubrication of hoisting ropes does minimize corrosion and extend the life of the rope. It also protects the lives of the workmen.

Our records show that "Accidents Can Be Prevented by Proper Lubrication."

USE OF GREASE IN THE STEEL INDUSTRY

BY L. W. DEUTSCH
Sales Manager, Trabon Engineering Corporation, Cleveland, Ohio

The use of grease in the steel making industry has passed through marked changes in the past 20-25 years. These changes have been prompted by higher mill speeds, higher temperatures and increased cost of down-time and have been paralled by corresponding changes in mill and equipment design. As a result, the plant is cleaner and safer, the quality of the product higher and repairs to equipment minimized.

The developments of better greases and centralized lubrication systems have been closely integrated. The number of grades of grease will generally be limited to #00, 0, 1, and 2 consistencies. A typical general purpose grease, meeting requirements for water repellency and having ability to lubricate journal bearings, anti-friction bearings, sliding elements, etc., under shock loading, would be a lime-soap grease with added E. P. and stickiness agents. The oil should be 75 S.U. sec. at 210° F and the grease shou!d have a melting point of 170° F.

Greases are available which will withstand temperatures as high as 400° F and still be easily handled by a centralized lubricating system at the low temperatures encountered in a steel mill in winter. The high mechanical stability of these greases after long use makes them very valuable in a steel mill for many applications.

The producers of grease and the manufacturers of lubrication equipment are constantly at work developing better products and methods of application to the benefit, not only of steel plants, but to industry as a whole.

Engineered lubrication pays larger dividends .

DYNAMICALLY LOADED BEARINGS

BY MILTON C. SHAW
Professor of Mechanical Engineering, Massachusetts Institute of Technology.

In the past the hydrodynamic theory of lubrication of the conventional journal bearing, in which the shaft rotates at constant angular velocity while the bearing is subjected to a load that is invarient in magnitude and direction, has received considerable attention. However, a good many bearings encountered in practice do not operate under these relatively simple conditions; many practical bearings are subjected to rotating and fluctuating loads and frequently both bearing surfaces are in motion. This paper discusses such unsteady state problems with a minimum of mathematical profundity. The method adopted consists of reducing each system considered to an equivalent conventional journal bearing for which solutions are readily available.

A hydraulic analogy is presented for the dynamically loaded bearing which is useful in qualitative analysis. The operating conditions for a piston-pin bearing of a reciprocating engine are considered in detail in order to illustrate the principles discussed and their method of application. While the bearing considered is found to operate under a maximum unit load of 9400 lb/in^2,

the equivalent conventional journal bearing is subjected to a unit load of but 1520 lb/in^2, which is a reasonable value for a well designed conventional bearing. The very high load capacity of the piston pin bearing is thus accounted for by its dynamic conditions of operation.

DEVELOPMENT OF GREASE LUBRICATING SYSTEMS

BY A. J. JENNINGS
Vice President of The Farval Corporation, Cleveland, Ohio.

This paper will outline the basic principles involved in the several systems currently being supplied by the leading lubricating system manufacturers for grease lubrication of industrial bearings.

All centralized systems of grease lubrication employ the piston displacement principle of measurement, whereby one or more pistons reciprocate in a cylinder to discharge a measured amount of grease, at pressures adequate to overcome the bearing resistance. These pistons and cylinders are incorporated in lubricant measuring valves, usually located adjacent to the bearings and they in turn receive their supply of lubricant from a central pumping unit, located at a convenient point and connected to the measuring valves by hydraulic piping. There are four basic methods for reciprocating the pistons in the lubricant measuring valves:

The first method is the so-called single line system whereby pistons move forward by hydraulic pressure applied to the lubricant in a single supply line, and move back under the force of a spring when the pressure is relieved in this main supply line.

Another method consists of reversing the flow in a main supply line loop, which causes the pistons to move in one direction when lubricant is pumped through this loop and to move the pistons back again when lubricant is pumped through the supply line loop in the opposite direction.

The third method consists of a single line system with lubricant flowing in one direction only and delivering a given quantity of lubricant to a measuring valve block, which causes the pistons to reciprocate and thus to divide this quantity of lubricant among the several outlets of the valve block.

The fourth method employs two parallel supply lines and, by alternate application of the pressure to these two lines, the pistons in the measuring valves are moved from one end of their cylinders to the other, discharging measured quantities of lubricant with each operation.

The paper will include illustrations and drawings covering the four methods outlined and will explain how these principles have been incorporated in the design and construction of each individual system.

DIRECT MEASUREMENT OF PISTON-RING FRICTION IN AN INTERNAL COMBUSTION ENGINE

BY JAMES C. LIVENGOOD
Member Res. Staff, Sloan Laboratories for Aircraft and Automotive Engines, Massachusetts Institute of Technology, Cambridge, Mass.

A special engine was designed and constructed to permit direct measurements of the friction forces which occurred between the piston rings and the cylinder wall when the engine was firing and delivering power in a normal manner. The measurement of these forces was accomplished by mounting the cylinder sleeve on calibrated springs which permitted small elastic motions of the sleeve in a direction parallel to its axis. The sleeve motion was recorded on a continuously moving photographic film by means of a suitable oscillograph; both optical and electronic methods were used. The engine could be operated with the usual connecting rod or with a crosshead mechanism which permitted only the piston rings to touch the cylinder sleeve.

"Running-in" tests were made with several combinations of ring and sleeve materials, and piston rings with high and low diametral tension were tested. The effects of engine speed, engine load, and cylinder water jacket temperature were determined. Profilometer measurements and photomicrographs showed changes in surface characteristics which may account for the reduction of friction during "running-in," since the corresponding changes in ring tension were unusually slight.

NON-FLAMMABLE HYDRAULIC FLUIDS

BY C. M. MURPHY
Sr. Research Chemist, Naval Res. Lab., Washington, D. C.
and
W. A. ZISMAN
Head Lubricants Div., Naval Res. Lab., Washington, D. C.

The properties required of hydraulic fluids are outlined and discussed briefly. The needs for less flammable fluids for certain commercial and military applications is shown. A summary of the methods of evaluating the flammabilities of fluids and the conclusions as to the relation of flammability to chemical composition of all classes of fluids studied to date are presented.

Fluids reviewed include petroleum oils, carboxylic, phosphate and carbonate esters, glycols, ethers, polyglycol ethers, silicones, chlorinated and fluorinated compounds and water-base fluids. Future possibilities for obtaining more fire resistant hydraulic fluids are outlined and a number of promising directions for the synthesis of more suitable organic fluids are indicated. Emphasis is given to the time-consuming nature of the research and development necessary to perfect new types of hydraulic fluids.

The action of fire-resistant additives like volatile "snuffers" and non-volatile "quenchers" is imperfectly understood and the need for physico-chemical research on this problem is evident. The effect of high boiling liquids in the hydraulic fluid range on the properties of elastometers is necessary to help guide research and development work on new fluids and suitable packings.

GREASE LUBRICATION IN THE MACHINE TOOL INDUSTRY

BY E. RALPH HARRIS
Manager Industrial Sales, Stewart-Warner Corporation, Chicago, Illinois

The subject of grease lubrication in the Machine Tool Industry is controversial and must be approached with an open mind, recognizing that our ultimate aim is to secure "best results."

The moving parts of the machine that do work can be classified into basic mechanisms and the problem of their lubrication must be approached with due consideration of the full range of conditions over which they operate. In the final analysis, a decision must be made as to the following: 1) Where to lubricate, 2) What product to use, 3) How often to lubricate, and 4) How lubricant should be applied.

Typical illustrations will be given where grease lubrication on machine tools has proved effective and profitable.

A simple set of rules can be used to guide the lubrication engineer in deciding where grease lubrication will give best performance.

HYDRODYNAMIC ASPECTS OF POROUS BRONZE BEARINGS

BY THOMAS BENTON HOWE
Sperry Gyroscope Co., Inc., Great Neck, Long Isl'd, N. Y.

Porous metal bearings have been associated in the literature with thin film conditions. It is the purpose of this paper to show that these bearings operate in a unique manner which is neither thin film nor thick film but can best be represented by a modified form of the Petroff equation. The mechanism of operation is discussed through a study of the effect of "run-in" and artificially induced "run-in."

Heat transfer equations are developed for thin walled castings and these, in combination with the modified Petroff equation and several design limits, are employed as the basis for a series of design charts giving oil selection and load-speed data.

The common pv factor is discussed in its relation to these equations and the limitations of such a factor are emphasized.

NACA FRICTION STUDIES OF LUBRICATION AT HIGH SLIDING VELOCITIES

BY EDMOND E. BISSON
Head of Lubrication, Friction and Wear Research Section, NACA Aircraft Engine Res. Lab., Cleveland, Ohio.
and
ROBERT L. JOHNSON
Senior Engineer in Lubrication, Friction and Wear Research Section, NACA Aircraft Engine Res. Lab., Cleveland, Ohio.

Kinetic friction experiments were conducted on steel specimens with various lubricating films over ranges of sliding velocities between 50 and 8000 feet per minute and loads from 269 to 1543 grams (126,000 to 225,000 pounds per square inch initial Hertz surface stress).

The lubricating films included in the investigation were: various iron oxides, supplemental lubricants such as molybdenum disulfide and free sulfur as an additive agent. The roles of the various iron oxides were established and indications were that Fe_3O_4 was beneficial in reducing friction, whereas a-Fe_2O_3 was not beneficial. Molybdenum disulfide was very effective in reducing friction, and was very tenacious, was chemically and thermally stable, and consequently indicated possibilities for use as a supplemental lubricant under extreme conditions. Analytical considerations of lubrication with extreme pressure additives suggested the hypothesis that rate of chemical reaction between surfaces and additives is a limiting factor. In support of this hypothesis, experimental evidence was found indicating lubrication failures at high sliding velocities for solutions of sulfur in cetane. Above the critical velocity, friction showed a definite increasing trend and mass surface welding occurred. Variations in load and sulfur concentration had no appreciable effect on the sliding velocity at which lubricant failure occurred.

GREASE APPLICATION TO MINING MACHINERY

BY M. B. LAWTON
Division Manager of Detroit and Cleveland Branches, Lincoln Engineering Co.

Thousands of dollars are squandered daily in the coal mining industry by lost production, parts replacement, maintenance overhead, employee accidents and decreased machinery efficiency resulting from two simple causes: 1) Improper selection of lubricants, 2) Failure to standardize on modern methods for their application.

In regard to lubricant selection, progressive mine operators have kept step with the lubricant industry and are today using one grease on jobs where three or four were formerly employed. The results thus achieved mean better lubrication, lower prices on quantity purchases, fewer drums, less waste, less guess work on the part of the oiler, and less lubricating equipment.

The finest lubricant obtainable depends for its results on the manner in which it is applied. Mine cars, coal loaders and other machinery used in underground mines operate in such close quarters that manual application of grease is impossible. In the case of mine cars, which are constantly in and out of the mines, lubrication at regular intervals overground and the employment of a well-situated lubrication pit with air or electric operated drum pumps is the most efficient.

Coal loaders and other machinery, confined to the mine, are subjected to dust and abrasives for long periods of time without lubrication. Considerable savings have resulted from equipping such machines with a simply constructed, centralized lubricating system which supplies clean, measured shots of grease to each bearing at frequent intervals during operation. The same type of system is being used with equal success on cleaning plants (tipples). In one case, the eccentric, crankshaft, and pillow block bearings of the shakers, which had been replaced twice yearly, have operated continually and handled in excess of 5 million tons of coal during the past three years without failure from faulty lubrication. Similar experiences can be cited for other machines and other pieces of equipment.

ANTI-FRICTION BEARINGS PAY DIVIDENDS ON TEXTILE MACHINERY

BY CARL A. BERG
Member Engineering Staff, The Fafnir Bearing Co., New Britain, Connecticut.

The textile industry, especially since the coming of man-made fibers, has become a modern, scientific precision industry, in which the supreme test of any piece of machinery is the service it renders under all conditions of hard and continuous usage. At first gradually, and of late much more rapidly, textile men have been replacing their old plain bearings and now anti-friction bearings have become an essential component in this vast empire of complicated machinery. However, no anti-friction bearing can be better than its lubricant.

Correct bearing designs in textile machinery, and correctly employed lubricants evolved by the petroleum chemists have brought maintenance costs down, saved power, increased machine efficiency and produced better grade textiles. Getting rid of the oilcans, as effected in changing from plain to ball or roller bearings, grease-lubricated, has brought about: enormous savings in cost of lubricant and the labor of applying it; added machine productivity through less downtime for oiling; less contamination of yarn and woven goods; elevated speeds.

Two problems, however, are currently confronted: friction oxidation or "fretting corrosion," as associated with oscillatory motion, and the "drying" of certain synthetic lubricants at elevated temperatures. To completely solve these we must again enlist the aid of the grease chemists who have already done an outstanding job.

GREASES—THEIR USES IN ANTI-FRICTION BEARINGS

BY J. H. GUSTAFSON
Chief Chemist, Marlin-Rockwell Corp., Jamestown, N. Y.

One of the most important features in the proper care of anti-friction bearings is lubrication. It only needs one lubrication failure to mar the symmetry of a bearing. Once the surface of the races or rolling elements become roughened, the effects are cumulative due to the rolling action, and complete bearing failure is inevitable.

In addition to minimizing frictional heat by reducing friction between the moving elements, a grease for the lubrication of anti-friction bearings should also protect the highly finished surfaces with a film of lubricant and prevent corrosion by moisture, acid, fumes, etc. In many cases the lubricant should also form a seal between the shaft and the housing to exclude dirt, moisture, foreign matter, etc.

In special applications such factors as stability at high temperatures, low torque values at low temperature and improved water resistance may be most important in selecting the proper grease. However, the most desirable properties for the lubrication of anti-friction bearings, under normal conditions, can be summed up as: first, oxidation stability; second, working stability and third, cleanliness.

It has been estimated that more than 90% of all anti-friction bearing failures are due to dirt, either dirt which has found its way into the bearing or dirt in the grease when it is applied. Anti-friction bearings are particularly sensitive to dirt and foreign matter because of the very high unit pressure between the rolling elements and the races. This dirt may become actually imbedded in the race path and the rolling of the ball or roller tends to break away metal particles around the periphery of the crater formed by the imbedded particle and bearing failure is only a matter of time.

IMPROVED HIGH-SPEED ROLLER BEARINGS

BY D. F. WILCOCK
Head of Bearing and Lubricants Center, Thompson Lab., General Electric Co., West Lynn, Massachusetts.

Studies of 95mm precision roller bearings with brass roll separators at 7,500 rpm and 500 pounds radial load have shown that they will operate quite successfully with very scanty lubrication. However, under such conditions transfer of brass to the steel parts on which the separator rubs is observed so that trouble under such conditions may be experienced eventually. If the bearing is operated without lubrication failure will occur in a few seconds to a few minutes. Special surface treatment of the separator has made it possible to extend the ability to run dry to hours rather than minutes and to eliminate most of the metal transfer under scanty lubrication conditions.

RAILWAY LUBRICATION

BY WM. M. BARR
Head of Chemical and Physical Laboratories, Union Pacific Railroad, Omaha, Nebraska.

Lubrication of railroad engines and cars presents many problems which can be satisfactorily solved only by careful consideration of the specific requirements of each application. A number of current practices and the reasons for them are reviewed in the expectation that an open discussion will be mutually beneficial.

Among the topics relating to the lubrication of cars which will be considered are, friction and roller bearings for both freight and passenger service, effect of ever-increasing speeds and loading, choosing between oils and greases, and general requirements of oil lubricants.

Under steam engines, the general requirements of oil for valve mechanisms and the special demands of higher steam pressures and temperatures will be considered.

The requirements of lubricants for diesel engines will also be presented from the user's point of view. Topics will include a review of available oil types, functions of additives, effect of mixing additive oils, need of filtration and cooling and maintenance of oil pressures. Problems related to auxiliary equipment include lubrication of compressors, governors, accessories, traction motor bearings and driving gears.

The foregoing abstracts do not cover the complete list of papers to be presented at the Convention. Unfortunately, a number of the abstracts missed the deadline.

These abstracts present a general picture of the subjects to be covered. The Co-Chairmen, M. E. Merchant and A. F. Brewer, and members of the National Program Committee, are to be highly commended for their selection of papers which cover lubrication in all of its phases.

"PHYSICAL PROPERTIES OF LUBRICANTS"

A.S.L.E. announces the publication of the first of a series of 14 Monographs. This volume will be available at the Annual Convention in New York, beginning April 11th. With this initial number, we inaugurate a publication program, making available in convenient form, fundamental knowledge on lubrication. Each book will be prepared and written by experts in a particular field of lubrication. The entire series is being compiled by the Educational Committee under the able Chairmanship of D. D. Fuller, Columbia University. A few of the subjects appearing in this introductory work are:

Viscosity

Density and Specific Gravity

Cloud and Pour Points

Flash and Fire Points

Carbon Residue

Neutralization Number and Interfacial Tension

Saponification Number

Emulsification

Specific Heat

An Extensive Bibliography

LUBRICATION OF TEXTILE EQUIPMENT *

By John R. Crotty†

This discussion on textile-loom lubrication is divided into two sections; the first dealing with test methods and procedures employed in the selection of the most suitable lubricants for my company in the past, the second section pertaining to "additives" and the selection of loom lubricants based on performance characteristics rather than specifications.

In the late thirties our Research Laboratory received the following communication from the Vice President of the Loom Works under the heading *"Loom Lubrication."*

"Much confusion exists in the textile-loom industry with reference to the proper selection of lubricating oils and greases. For some time we have been communicating with the various oil companies in an endeavor to draw up a recommended list of lubricants to give to our customers. We are also desirous of obtaining charts showing the frequency with which various parts of the loom should be lubricated. Our difficulties are in obtaining like products. For example, one oil company has recommended an oil with a viscosity of 200 seconds at 100 F., whereas another, for the same purpose has recommended an oil with a viscosity of 900 seconds at 100 F. We must iron out these differences and establish definite Loom-Lubrication specifications. In addition, please advise as to the possibility of specifying and marketing these lubricants by the Loom Works."

We immediately dismissed the marketing of lubricants by advising that we were in the loom not the oil business.

As to the statement, "our difficulties are in obtaining like products," we just couldn't believe this to be true, and we immediately contacted all major oil companies in the United States and Canada, requesting that they send in their textile lubrication engineers for a conference on general purpose lubricants for looms.

Following these conferences the oil engineers were requested to confirm their recommendations in writing and submit samples for examination and test purposes. To our amazement the specifications ran all over the lot. Viscosities ranged from 200 at 100 F, to 1500 at 100 F. Some recommended straight mineral oils, others compounded, while others recommended oils of the dripless and non-fluid varieties. As far as greases were concerned, some recommended soda soap, others lime, soda-lime, sodium-potassium, etc.

When confronted with these differences, many of the oil companies were still convinced that their recommendations were correct, and requested that we examine and test their products.

This was a large order but we accepted it. Following chemical analysis of each product, flash, fire, viscosity, cold and specific gravity tests were made and recorded. In addition, friction, film strength, wear and abrasion tests were conducted on a Timken Tester.

Greases submitted were analyzed by the usual chemical methods and tested for stability and oxidation. BEC agitation tests showing changes in consistency and measuring the starting and running torque were also made.

Briefly, the results of our studies *convinced us* that chemical analysis, flash, fire and viscosity *were of little value*. Friction, film strength, wear and loom tests revealed that compounded oils possessed properties of greater adhesiveness, oiliness and minimum of friction, than straight mineral oils with the same viscosities.

The tests also showed that highly refined straight mineral oils were far superior to ordinary run of the mill straight mineral oils with similar viscosities. Different crudes and methods of refining accounting for such variations. Although the tests revealed that compounded oils and some oils of the dripless variety were superior to straight mineral oils of equal viscosities, there was one fly in the ointment namely, separation. It was found that they clogged up the filters, leaving soapy and gum-like deposits. This condition eliminated these oils as a general lubricant, inasmuch as many of our looms were equipped with felt pads, wick feed, and one-shot systems.

As far as the greases were concerned, chemical analysis, penetration, etc., was not the answer to our problem. We had to think of starting and running torque and therefore BEC tests were resorted to. Starting up of looms on a Monday morning in many of the northern mills, constituted a severe headache to many mill men. Many of the looms could not be started up. Furthermore, we had to think of greases that would withstand high relative humidities as encountered in many mills.

After extensive research studies and tests of lubricants, followed by service runs in the mill, the Laboratory recommended the adoption of the following specifications as a starting point to be improved upon as occasions arose.

Lubrication Specifications

Specifications of lubricants for Crompton & Knowles Looms are classified under four headings which include two general purpose oils and two general purpose greases.

SPECIFICATION 1 Oil for breaking in looms	Highly refined straight mineral oil. Viscosity Saybolt Universal 225 to 300 sec. at 100 F. Flash point minimum 340 F. Burning point minimum 390 F.
SPECIFICATION 2 Oil for normal operation	Highly refined straight mineral oil. Viscosity Saybolt Universal 500 to 750 sec. at 100 F. Flash point minimum 375 F. Burning point minimum 425 F.
SPECIFICATION "A" Grease for plain and anti-friction bearings	ASTM penetration 240/340 approx. Mixed-base (soda-lime) soap-soda 20%—soap-calcium 3%. Greases employed for looms shall be a smooth, homogeneous mixture of mineral oil and soap (preferably soda-lime). Furthermore, they shall be as free from acid forming tendencies as possible, have a high melting point, display no signs of separation or change of structure, and show a low starting and running torque. Greases containing any solid fillers are positively harmful and should not be used.
SPECIFICATION "B" Grease for starting looms	For starting plain bearing looms equipped with grease fittings, we recommend a fluid lubricant such

*Presented before the Boston Section of A.S.L.E., January 10, 1949.

†Associate Director of Research, Crompton & Knowles Loom Works, Worcester, Mass.

as ALEMITE 356, manufactured by the Alemite Corporation, or Extra A-OO, manufactured by the New York, New Jersey Lubricant Company.

On looms where a specialty oil is desired which will scour readily and has great adhesive properties, etc., compounded oils of 500-750 viscosity Saybolt Universal at 100 F, are recommended where hand lubricated bearings are employed.

Non-fluid oils have merit, but should be confined to bearings lubricated by hand. Do not use in wick feed or one-shot systems.

Polymerized oils have properties of great adhesiveness, but should not be used in wick feed or one-shot systems.

Semi-fluid aluminum soap thickened oil approximately 7% aluminum soap, having a viscosity of 2520 seconds at 100 F, and 120 seconds at 210 F, is recommended for pick balls, cams, slides, etc., due to great adhesiveness and clinging properties. Other non-fluid and polymerized oils are also very effective and can be used for such parts.

Overlubricating

One of the most frequent causes of difficulty particularly in the use of grease as a lubricant for anti-friction bearings is the practice of forcing an excessive amount into the housing, by means of a pressure gun. The presence of a large volume within a bearing will usually result in high operating temperatures due to the working or churning of the lubricant by the rolling elements and retainer, and seriously impair the useful life of the lubricant. This may be through oxidation or sludging of the oil or actual disintegration of the grease. Moreover, leakage due to over-application may result in considerable contamination of the goods being processed. Every effort should be directed to impressing upon operators or oilers, that all anti-friction bearings have a certain capacity for lubricants which should not be exceeded.

At this point I might add that best lubricating conditions are obtained when they are under one competent man, who is paid well for his job and takes an interest in his job, and is charged with the responsibility to man this work. When such an individual is supplied with charts and general information showing the points to be lubricated on the looms along with data on proper lubricants to be used, the machines receive the correct lubrication at the right time.

Many times companies make extensive surveys and issue excellent recommendations only to have them put into the hands of people who would not or could not follow them. There must be an educational program established, training the operators as to their duties and responsibilities.

The following chart gives the schedule of lubrication for C&K Type "S" precision silk and rayon looms, based on average conditions on a single shift basis. This

LUBRICATION SCHEDULE FOR TYPE S LOOMS

Based on average conditions of mill operation on a single shift basis

PARTS LUBRICATED	PLAIN OIL CUPS OR OPEN OIL HOLES	WICK FEED OIL CUPS	GREASE FITTINGS
Bottom shaft bearings—Roller	Monthly	——	Every 3 months
Crankshaft bearings—Roller	Monthly	——	Every 3 months
Dobby drive shaft bearings—Roller	Monthly	——	Every 3 months
Lay rocker shaft bearings—Roller	Monthly	——	Every 3 months
Take-up friction roll bearings—Roller	Monthly	——	Every 3 months
Motor driven clutch gear on crankshaft*	Every 3 months	——	——
Waste packed motor bearings	Every 3 months	——	——
Bottom shaft bearings—Plain	Daily	Twice weekly	Twice weekly
Crankshaft bearings—Plain	Daily	Twice weekly	Twice weekly
Crank connectors	Daily	Twice weekly	Twice weekly
Swivel yoke for shipper lever	Daily	Twice weekly	Twice weekly
Rocker shaft bearings—Plain	Daily	Twice weekly	Twice weekly
Harness cam shaft bearings	Daily	Twice weekly	Twice weekly
Dobby drive shaft bearings—Plain	Daily	Twice weekly	Twice weekly
Dobby rocker shaft bearings	Daily	Twice weekly	Twice weekly
Knowles head cylinder shaft bearings	Daily	Twice weekly	Twice weekly
Knowles head upright shaft bearings	Daily	Twice weekly	Twice weekly
Chain shaft bearings	Daily	——	——
Look knife shaft bearings	Daily	——	——
Take-up friction roll bearings—Plain	Daily	Twice weekly	Twice weekly
Intermediate take-up gear shaft bearings	Daily	Twice weekly	Twice weekly
Picking shaft bearings	Daily	Twice weekly	Twice weekly
Picking roll studs	Daily	——	Twice weekly
Picker rod	Twice daily	Daily	——
All other oil holes and oil cups	Daily	Twice weekly	——

All other parts of the loom, such as shuttle box guides, dobby parts, cam surfaces, rolls, gears, etc., should be lubricated whenever inspection reveals that lubrication is necessary.

*Reservoir in hub of gear should be filled with oil not higher than the bottom of the crankshaft (approximately ¼ pint of oil).

PRECISION LET-OFF—The oil in the dash-pot should be renewed about once a year. A straight mineral oil with a viscosity index of *not over* 500 seconds at 100° F. should be used. In no case should a highly saponified oil having so-called non-fluid properties be used.
One or two drops of oil should be placed on the handwheel shaft every day or two for lubricating the ratchet.
The two oil cups on the housing can be supplied with a general purpose oil once a day for the first two or three months. After that it will be found that the grease from the gear case will supply sufficient lubrication.
The worm gear case is packed with grease at the factory and should require little or no attention for several years.

For general practice, oil is usually recommended for plain bearings, and grease or oil for anti-friction bearings. The felt wicks in wick feed oil cups should be removed and rinsed in a solvent every six months.

The housings for anti-friction bearings should be flushed out with a solvent at least once a year and new lubricant put in. At no time should the housings be over half full of lubricant.

schedule should be taken only as a suggested starting point in determining the actual frequency of lubrication under specific conditions.

Note

It is important to observe that specifications in themselves cannot define completely the lubricating properties of an oil or grease. The methods used in refining and manufacture have an important influence on the performance of the lubricant in service. Consequently, apart from fulfilling the specifications given it is most advisable to select only high grade products made by recognized and reliable manufacturers.

Moreover, it is our recommendation that customers purchase their oils or greases on the seller's guarantee and not solely on its brand or trade name which we may have tested and recommended.

So much for the past, now for the present. Early in 1948 the subject of loom lubrication was reopened. Studies revealed that present day lubricants and the lubrication of our modern high speed looms presented a different story than back in the thirties. Accordingly, Crompton & Knowles loom lubrication specifications, previously issued and currently presented here to you, were voided.

With the advent of higher speed, more intricate mechanisms and the continually increasing severity of conditions, we believe the application and use of specially treated lubricants, with certain additives or inoculants, is as necessary today as the alloying of steel and irons was to the steel industry fifty years ago.

There are several reasons why this is desirable over and above increased speeds, close tolerances and heavier loads. One of these is the protection of fabrics. Oil spots on goods are a source of considerable expense to the mill owner. We must have treated oils which do not flow or throw so freely as to reach the fabric regardless of whether the oil is or is not carefully applied. Furthermore, many looms in service are lubricated according to the specific convenience or the conditions of the mill. It is not uncommon, therefore, to find certain bearings oiled each morning, each week, or when the warp is out.

Moreover, where the lubrication of looms is left in several hands, with the weaver, the loomfixer, and the oiler, all expected to lubricate certain parts, one cannot be confident that every bearing is oiled at proper intervals, or in the proper manner.

A further phase of the problem is recognized in the effect of lint. This is particularly true with looms weaving cotton goods. Such lint may be caught in the bearings so as to form so-called "tails". Through capillarity these draw the oil from bearings leaving insufficient quantities for proper lubrication.

In view of what has been said on requirements of present day lubricants for the efficient operation of looms, is my company going to carry out another extensive and long drawn out research, and issue a new set of lubrications, just to eliminate undesirables as was the result in the past? *The answer is no.*

We are thoroughly convinced that lubrication, like medical treatment becomes hazardous when practiced without the requisite knowledge, skill and technical data. Too many time in an organization, and ours is no exception, some well meaning individual feels that he is qualified to write specifications on lubricants when he is not capable of doing so. Lubricants have much in common with penicillin and the sulpha drugs. They are used most successfully when prescribed by experienced practioneers. *The catch is, we don't even know truthfully and accurately what a lubricant is.* How then can we define quality or performance?

Mr. Crotty is an Alumnus of Holy Cross College. He received his early metallurgical training under Frederick L. Coonan, D. Sc., Professor of Chemistry and Metallurgy, Postgraduate School, U. S. Naval Academy, Annapolis, Md. Mr. Crotty has written various technical articles, and is a member of societies associated with the metal industry.

Do you know that a typical lubricant supplier may carry on his books low priced oils of 100-150-175-185-200-225-250-275-285-300-315, etc., seconds oil at 100 F, about half of them, because somebody wrote a specification 5 or 10 points different from the rest.

The situation has achieved the heights of comedy—in a tragic sort of way.

What do we know about the hundreds and hundreds of lubricating oil additives now in existence, which either impart new properties to an oil or else improve those properties which the oil already has? Very little, although at the present time I believe there are over 500. These additives may be divided into two major classes.

1. Those which are useful for their properties as associated with the phenomenon of oil oxidation, such as anti-oxidants, anti-corrosives, and detergents.
2. Those which are added to an oil to improve some physical property of the oil such as viscosity index, pour point, film strength, rust protection and foaming characteristics.

The nature and geographic source of the hydrocarbons determine what additives are compatible and effective. The oxidation inhibitor that is effective with a mid-continent base oil is almost certain to fail with a Pennsylvania base oil.

These are only a few examples of the futility of a specification that is based on what components should be permitted. Many textile lubricants on the market today are being made employing as many as 5 or more different additives. These effect marked improvement with respect to oxidation, stability, pour, foaming tendency, detergency, film strength, corrosive properties and others.

Lubricating oil additives are here to stay, and will continue to grow, as did the additives and inoculants in gray cast iron. Incidentally, the application of additives to Lubricants has much in common with additives to cast iron. For example, most cast irons definitely are improved by inoculants or additives, as are lubricating oils.

Inoculation of cast iron is a process of adding a material to molten cast iron *for the purpose of controlling the structure, and increasing physical properties to an extent not possible by control of chemical analysis and other normal variables.* For cast iron we could

very easily substitute lubricating oil, inasmuch as the same benefits accrue, i.e., closer control of structure and the increasing of such properties as film strength, wear, stability, corrosion resistance, etc.

In cast iron as in lubricating oil it is impossible to determine from the chemical analysis the effect of the inoculant or additive. In fact, it is almost impossible to tell from chemical analysis whether the iron was or was not inoculated.

In many cases, marked changes in the properties of gray cast iron, or lubricating oils, are effected with an insignificant or imperceptible change in the chemical analysis.

Effect of additives on the mechanical and physical properties of gray cast irons, or lubricating oils are many and diversified, but their basic function is to control the matrix structures to such an extent not possible by the control of chemical analysis alone.

Incidentally, last week we were requested by one of the oil specialty companies to review a list of lubricants it is now recommending and supplying for loom lubricants. These oils containing additives, while still complying to our specifications, as far as viscosity, flash, fire, pour, etc., are far superior to the straight mineral oils. By additions of certain patent additives the mill men are receiving today, from this Company, a general purpose oil with increased film strength, 2 to 3 times that of former straight mineral oils, plus oxidation and rust inhibitors.

As far as the chemical analysis is concerned it is practically impossible to break these oils down. Moreover, what additives were introduced and how much were added.

Lubricating oils have come a long way since the days of the old so-called Red Engine Oil for Textile Lubrication. The almost miraculous potentialities of additives present a constant and inspiring challenge to the oil technologist.

"Not what goes into it" but "what performance will it give" should be the objective of a sane lubricant purchase specification.

Today, my company believes that "performance standards should govern oil purchases." Purchases based strictly on specifications we feel, are gradually fading out of the picture in favor of purchases of products based on performance characteristics. Such products may command a somewhat higher price, but from the standpoint of over-all operating efficiency and economies, particularly under the critical service conditions of looms and other modern equipment, they will effect considerable savings to the consumer.

Are we the only people who express this belief? As the "Old Warrior", Al Smith would say, "Let's look at the records."

One gentleman, at a recent meeting of Textile Engineers in New England stated, "I would like to give you an idea of what the Army and Navy have been up against in the last four or five years. They started off with physical specifications on grease, and they found themselves so completely surrounded by border-line greases that all kinds of troubles began to exist, and as a matter of fact, they haven't caugnt up to the proper specifications yet. *New specifications will be built on performance.* Specifications of greases mean but little, but a performance test means a lot."

Another gentleman addressing an A.P.I. meeting in Los Angeles in 1947, advanced the following: "When our knowledge is scanty and fragmentary, it is sheer folly to attempt writing a serious purchase specification. Undoubtedly there is a growing evidence of the spread of a disease that can be classed as a true phobia, namely, a morbid fear of lubrication that we may call "lubriphobia." Like other phobias, this fear disease is closely associated with ignorance; ignorance of cause-effect relationships, lack of perspective and common sense.

One of the outgrowths of lubriphobia is a desire for specifications ior purchase of lubricants. This desire ranges from a plaintive plea to a harsh demand. Those who demand usually state that the manufacturers of lubricants have the knowledge needed to write purchase specifications. Not only can this allegation be denied but we can go even further and state that the combined knowledge of manufacturers, users, consultants and research workers is still not enough to permit the formulation of a purchase specification that will insure proper lubrication except for the simplest and least important mechanical device. That this statement is true is shown by the findings of a special group appointed to write purchase specifications for lubricants. Quoting from their report ASTM "Symposium on Oil Procurement Practices," June 1946. 'The most helpful thing that can be produced under our assignment at the present time, is a form of recommended practice to be followed in the purchase of lubricants.' "

I could continue on and on with such reports, but I would like to leave with you the following thoughts and conclusions:—

Conclusions

Several important conclusions emerge from this survey. Until we have a thorough knowledge why lubricants lubricate, until we have bearing surfaces precisely defined as to composition, dimension, and contour, lubrication will continue to be a professional activity not unlike the practice of medicine. Until the required methods of testing are revised to give performance results, a lubricant-purchase specification is obviously impossible.

Lubricant performance characteristics are those features and capabilities of a lubricant which enable it to perform properly all of its functions in actual service, but which can seldom be accurately measured by the usual physical and chemical tests.

Standards of lubrication performance can usually be determined by analyzing four factors. They embrace the effects of lubrication on production, maintenance, power and cost.

Crompton & Knowles, in a release of October 4, 1948 to the trade, which was covered very completely in V. E. Hillman's article "Performance Standards Should Govern Oil Purchases," June 1948 issue Textile World, is as follows: "Crompton & Knowles recommends that customers purchase their lubricants based on performance characteristics and the seller's guarantee." Specifications in themselves cannot define completely the lubricating properties of an oil or grease.

With its own and the oil company's engineers, the mill should determine desired standards of performance for its particular equipment and operating conditions, and then require the supplier to meet these standards with products whose quality, suitability and uniformitv are warranted. The mill then relies on the integrity and reputation of the oil company's products as the best means of assuring maximum performance at minimum cost. It has been said "that the most valuable ingredient of any product is the maker's good name"—and this applies to lubricants beyond almost any other material.

THE FRICTION OF DRY AND LUBRICATED SURFACES*

as determined by the Stick-Slip method

Gulf Research and Development Company, Pittsburgh, Pennsylvania

by

F. Morgan

Mr. Morgan received his college education at Ohio University, Purdue, and Ohio State University. He has been associated with Gulf Research and Development Company since 1936, as Assistant Chief of the Physics Division since 1944. His work at Gulf has been concerned with lubrication, oil production and radioactivity.

M. Muskat

Mr. Muskat took his college training at Marietta College, Ohio State University, and California Institute of Technology. He has been employed by Gulf Research and Development Company since 1929, as research physicist to November, 1935, and as Chief of the Physics Division since that date. At Gulf he has been engaged in research on the mechanics of oil production, theoretical geophysics, and the physics of lubrication.

D. W. Reed

Mr. Reed attended Carnegie Institute of Technology. He joined the Gulf Research and Development Company as a physicist in 1929, and has there been engaged in research on the flow of gases and liquids through porous media and the physics of lubrication.

Introduction

In spite of the importance of the coefficient of friction from a practical point of view, a brief inspection of the usual tables and handbooks is sufficient to show the inadequacy of such data. Thus the twenty-sixth edition of the Handbook of Chemistry and Physics lists as the coefficient of friction for metal on metal, dry 0.15-0.20, and metal on metal, wet 0.3. The reference shows that these values are from Rankine's compilation in 1858 and the Smithsonian Tables.

It is true that more recently the dependence of the friction upon the type of metal has been generally recognized and values of the coefficient for various metal combinations, dry and lubricated, have been published. The researches of Campbell[1], Tomlinson[2], Beare and Bowden[3], Bowden and Leben[4], Bowden and Hughes[5], Ernst and Merchant[6] and others have contributed much to the available data. A comparison of the published data, however, will show many and large discrepancies. To those who have only a superficial knowledge of friction measurements the variations will appear to be unjustifiable. Further consideration, abetted by a few experiments, however, will usually lead the skeptic to the realization that there are many variables that are extremely difficult to control, and consequently that the coefficient of friction for a given pair of metals will depend on many factors. In fact he may agree with Bowden and Leben[4] in their postulate that friction may not be constant. Actually a study of the work of Bowden and his associates as well as the traces included here will show that in many cases the coefficient of static friction (as determined from the maximum displacement on the trace) does vary, as does also the coefficient of kinetic friction. However, such variations are believed to be due to lack of uniformity in surface characteristics and contact area.

In the following the results are given of a friction survey of various metal combinations as made with the stick-slip apparatus built in this laboratory. While no claim is made for the absolute accuracy of the friction values, the data are representative of the type of results obtained with the apparatus for surfaces prepared by a rather uniform, though arbitrary method.

Apparatus and Experimental Technique

The apparatus[7], which is shown in Figs. 1 and 2. is identical in basic principle of operation with that developed and used by Bowden and Leben[4]. It consists essentially of a horizontal rotating table holding the "plate", on which elastically presses down a spherically ended rod—the "slider"—attached to a cantilever. The latter is supported by a wide torsion ribbon extending vertically along the axis of the table. The motion of the slider is recorded by reflecting a light beam from a mirror attached to the cantilever and focused on moving photographic paper. In this way is obtained a "trace" of the slider motion from which, by using suitable calibration data, the horizontal friction force acting on the slider can be determined. On measuring, in addition, the normal force with which the slider presses on the table, the friction coefficient may be calculated. Besides the "stick-slip trace" of the slider motion, a timing line, generated by a chronograph connected to an oscillograph element, was projected on the photographic paper, as well as an oscillograph trace of the voltage drop across the slider-plate contact, which was proportional to the contact resistance.

Several examples of various types of traces, illustrating particular features to be discussed later, are shown in Figs. 3 and 6 to 15. Eleven metals—lead, high tin babbitt, zinc, copper, constantan, 17ST aluminum, brass, tin, Wood's metal, 304 stainless steel, and SAE 52100 steel—were used for sliders, and eleven—tin, Wood's metal, lead, high tin babbitt, copper, Tobin bronze, cast iron, 17ST aluminum, brass, 304 stainless steel, and SAE 52,100 steel—for the plates. For each of the 121 pairs of combinations, runs were made with the surfaces dry, with Gulf Pride SAE 20 oil, Gulf Pride 20 oil plus 3% Baker's U.S.P. oleic acid, and with a silicone having a V.I. of 142 and viscosity at 100F of 143 C.P. In addition to the 484 traces so obtained, 59 repeat runs were made, of which 45 were dry, 4 with Gulf Pride 20, 2 with Gulf Pride 20 plus 3% oleic

*Paper presented at Pittsburgh Convention of A.S.L.E.

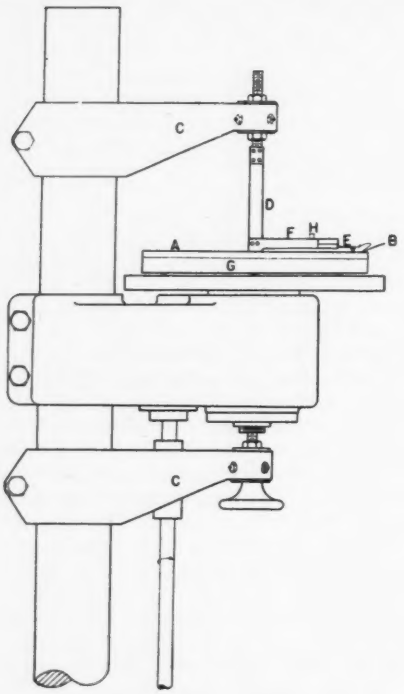

Fig. 1. Schematic diagram for stick-slip machine.

lent conditions at another time. On the other hand, in the great majority of instances where check traces were run, no great variation in trace character or absolute magnitude was observed. A fair estimate of the variation in magnitude of the average friction coefficient on a single trace is about 20%.

In spite of this rather large uncertainty in the actual numerical values to be given here, it is felt that the data have definite statistical significance from a comparative or relative point of view, since they were all taken by the same method and using the same technique. In particular, the force between the contacts was approximately 300 grams weight in all cases, with variations ranging from 275 to 325 grams. Moreover, the surfaces were all cleaned and treated by the same method, the ultimate condition being that obtained by abrasion under water. Finally, the same specimens of metal were used in each series of measurements with a given stationary or moving surface, in all four conditions studied. It is therefore felt that while the absolute magnitude of the friction coefficient may be influenced by the method and technique of experimentation, the relative values for different metal combinations and for different types of frictional conditions should be reflected by the data with considerable accuracy.

As indicated above the load range in these experiments was from 275 to 325 grams. This value is comparable to that normally used in friction measurements and is somewhat less than the value of 400 grams used by Bowden and Leben[4] in a number of their experiments. In spite of the moderate value of the load,

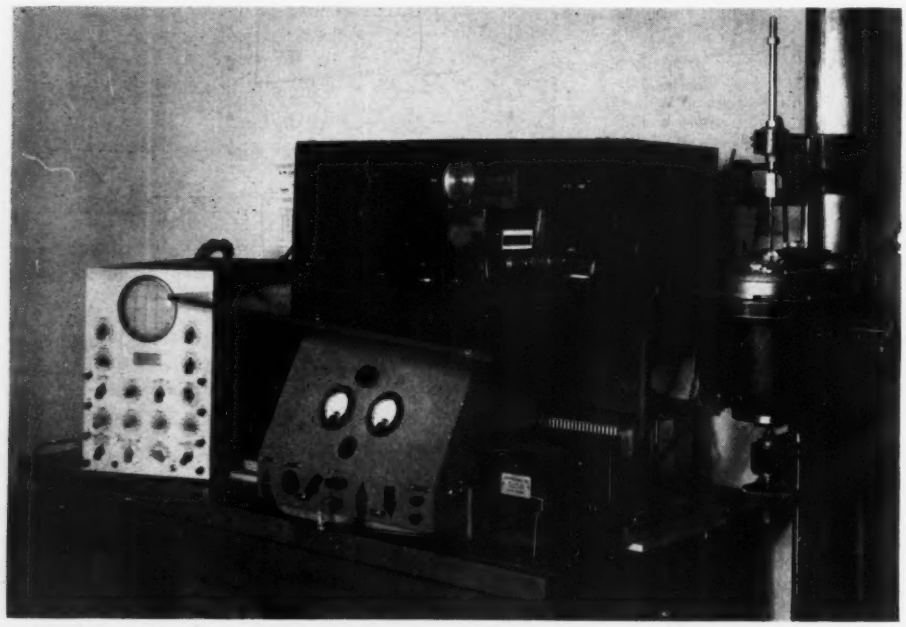

Fig. 2. Photograph of stick-slip machine and auxiliary apparatus.

acid, and 8 with the silicone. These provided the basic data for the survey.

No particular claim is made regarding the absolute and quantitative accuracy of the numerical values submitted here. While the precision of the individual measurements was quite satisfactory, in some cases the experiments showed a disconcerting degree of irregularity and a lack of reproducibility such that friction values measured from one trace might vary by as much as 50% from those obtained under apparently equivalent conditions at another time. On the other hand, in the great majority of instances where check traces were run, no great variation in trace character or absolute magnitude was observed. A fair estimate of the variation in magnitude of the average friction coefficient on a single trace is about 20%.

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As indicated above the load range in these experiments was from 275 to 325 grams. This value is comparable to that normally used in friction measurements and is somewhat less than the value of 400 grams used by Bowden and Leben[4] in a number of their experiments. In spite of the moderate value of the load, however, the pressure was actually quite high due to the small area of contact. The true value of this area is not known in any case but from the width of the track the estimated upper limit for the soft metal sliders is somewhat less than 1 sq. mm. On the basis of the above load, this corresponds to a minimum pressure of about 400 psi. Bowden and Tabor[5] have shown by conductivity measurements, however, that the true area of contact with loads of this magnitude is only a very small fraction of a sq. cm. This means

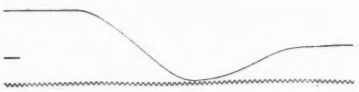


Fig. 3. High speed camera trace of Wood's metal sliding on Babbitt, dry. Timing frequency, 1920 cycles/sec.

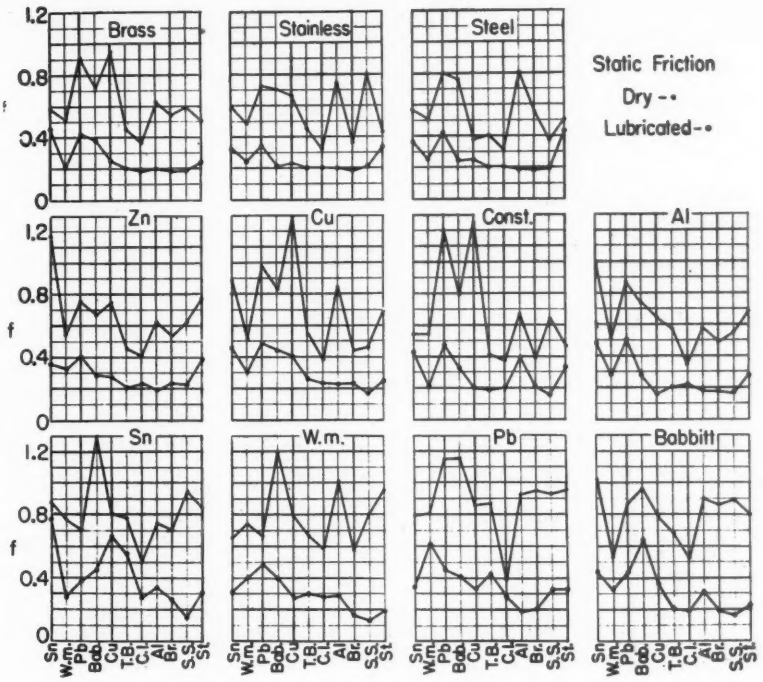


Fig. 4. Coefficient of static friction vs. plate material (abscissa) for various sliders.

that even with light loads the pressure may be sufficient to cause plastic flow of the metal or to break through the surface layers. Friction forces as determined here therefore consist of contributions due to plowing and shearing as well as to surface asperities and attractive forces between the metals themselves.

Accuracy of Data

Several specific points affecting the absolute accuracy of the data should be mentioned. In the first place, while solvents were used for removing the oils, cleaning of the surface was ultimately effected by abrading under water. This technique, in general, led to surfaces which would water wet. However, no special care was taken to detect, measure, or, in general, to remove any absorbed vapor or oxidized film which may have formed on the surfaces between the fina abrasion treatment and their use in the friction measurements. It was found, however, that some surfaces, notably 52100 steel, would oxidize very rapidly under these conditions. In such cases the rust was immediately removed by light abrasion, care being taken not to charge the surface with abrasive. No claim can therefore be made that the surfaces were clean in an absolute sense. Rather, it is more likely that they were all contaminated in a somewhat similar manner. The justification for proceeding with the survey and presenting the data even without certain knowledge regarding the state of cleanliness of the surface lay essentially in the feeling that the surfaces, however contaminated from a microscopic point of view, were cleaner, on the average, than those involved in practical use. Moreover, from the actual friction experiments there appeared to be no progressive change in the results with time, thus indicating that any contamination that may have been on the metal surfaces was not a highly variable source of error. Finally, the very fact that in all cases the addition of lubricants reduced the friction values below those for the dry surfaces seemed to indicate that no excessively tenacious absorbed oily films were present on the surfaces. At least they were not able to shield completely the true surfaces from the action of the lubricant. As a whole, therefore, it appeared that while oxidized or contaminating films were present, their effect was probably in the nature of a systematic or constant source of error. To obtain results more characteristic of the metals themselves, experiments should be conducted in a vacuum or in a controlled atmosphere. Practically, however, such data would probably be of significance only in extreme cases such as occur when the surface is torn off or ruptured leaving the underlying metal exposed.

Another uncertainty in the measurements was the absolute magnitude of the force between the sliding surfaces. This force was measured by a calibrated spring both before and after each run. The values so found frequently differed by 25 grams out of a total of 300. In such cases the average value was used in computing the friction coefficients. Beyond this degree of uncertainty any particular measurement of the normal force between the surfaces could have been in error by as much as 5% because of the inherent nature of the measurement.

A final source of error which often appeared to be far more serious than the others lay in the irregular nature of the traces of the slider displacement. Especially in the cases where both metals were hard the traces were sometimes so irregular that the measurement of the friction coefficient seemed rather meaningless. When either metal was soft, the first stick displacement was, in more than 50% of the traces, higher than those recorded for subsequent sticks, thus creating the question as to which should be used in evaluating the static friction coefficient. The decision was made to ignore the first stick, although it was recognized that the basic question regarding the uniqueness of the friction coefficient was not thereby solved.

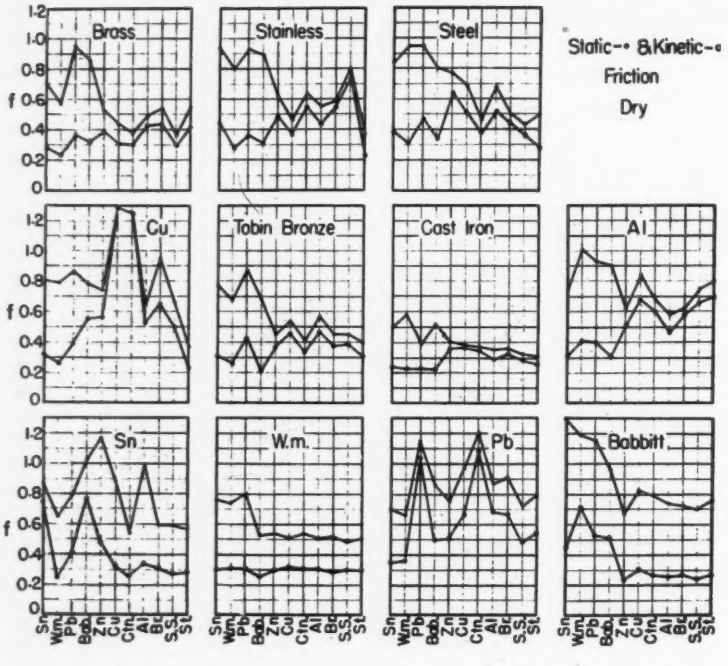


Fig. 5. Coefficient of static and kinetic friction vs. slider material (abscissa) for various plates.

It is appropriate to emphasize why the extensive survey reported here was made by the rather unconventional experimentation with the stick-slip apparatus. The reasons were three. First, as will be shown presently, the stick-slip apparatus permits a determination of both the static and kinetic friction coefficients from the same record. Secondly, these measurements refer to physical events that take place in quick succession and under virtually identical conditions, thus minimizing the uncertainty regarding the equivalence of the measurements when different types of apparatus are used for static and kinetic experiments. Finally, the stick-slip method automatically provides a quick sequence of measurements under practically identical conditions. Thus average values over what are in effect a number of distinct measurements can be readily made from each trace, and correspond to a total time of physical observation of only from one to three minutes. This latter feature is of special value in view of the inherent irregularity of independent friction measurements, as previously pointed out. Thus the data reported below are in each case the averages of from three to fifty individual experiments, as it were, even though the measurements may have been made on a single composite trace.

Calculation of Friction Coefficients

The literature on the stick-slip technique already brings out the fact that the maximum displacement along a stick trace perpendicular to the direction of film travel measures directly the static friction force, except for the insignficant effect of the inertia of the slider associated with the extremely slow table speed. Thus the static friction value can be determined by measuring the average maximum displacement of the stick traces and suitably converting into frictional force.

The determination of the kinetic coefficient of friction from traces, such as shown in Figs. 6-15, has not been hitherto clearly brought out in the literature. In fact, in most stick-slip traces published by Bowden[4] and his associates friction coefficient scales are attached as ordinates, with the implication that the whole phenomenon is one of fluctuating friction and that the range of ordinates covered by the stick displacements indicates the degree of fluctuation. No explicit interpretation of or correlation between the friction coefficient ordinate scales and the ordinary static coefficient of friction is indicated. In a paper by the authors[9] it was shown how the kinetic friction coefficient may be determined from an analysis of the slip back portion of the stick-slip cycle. This method, however, is extremely tedious and laborious, and obviously could not be used in an extensive statistical survey such as is reported here. A much simpler procedure was therefore used which provided a very easy way to get the average friction coefficient during the slip back part of the cycle. This was derived in the following manner. The basic equation of motion for the slip part of the cycle is:

$$m\ddot{y} + k y = F_k, \qquad (1)$$

where m is the effective mass (or moment of inertia if the motion is considered as circular), k the restoring force constant, F_k the kinetic frictional force, and the damping term has been omitted as being negligibly small, as "free" vibration records actually showed. The energy integral is then given by:

$$\left[\frac{m\dot{y}^2}{2}\right]_a^b + \left[\frac{ky^2}{2}\right]_a^b = \int_a^b F_k\, dy. \qquad (2)$$

Taking the limits b, a as the beginning and end of the slip cycle, which are also the end and beginning of the stick phase, $\dot{y}$ will be zero at each limit*, so that:

*This will be strictly true if the coordinates are fixed on the moving table, and correct to a high degree of approximation if the small table velocity is neglected and the coordinates are kept stationary.

$$\int_a^b F_k \, dy = \frac{k}{2} (y_b^2 - y_a^2). \qquad (3)$$

Hence the average frictional force, $\overline{F_k}$, will be:

$$\overline{F_k} = \frac{\int_a^b F_k \, dy}{y_b - y_a} = \frac{k}{2} (y_b + y_a) = k \bar{y} , \qquad (4)$$

where $\bar{y}$ is the algebraic mean slider displacement, either during the stick or slip phases, assuming that the slider will stick the first time its speed falls to the table velocity. If the friction coefficient, and hence F_k, is constant, Eq.(4) gives an accurate expression for $\overline{F_k}$. However, even if it is variable, †Eq.(4) provides a well defined average for F_k. In either case, a measurement of the mean stick or slip back, displacement, $\bar{y}$, will give the average kinetic friction force or coefficient in the same units in which the maximum stick, or initial slip, displacement, y_b, gives the static friction force or coefficient. Thus:

$$\frac{f_k}{f_s} = \frac{(y_a + y_b)}{2y_b} = \frac{\bar{y}}{y_b} . \qquad (5)$$

Eq.(5) is the basis for the kinetic friction coefficient values reported here. Of course, both y_b and $\bar{y}$ refer to displacements with respect to the zero force position of the slider. Hence the latter was also recorded for each trace immediately following the stick-slip motion and the checking of the slider load. As a practical procedure for averaging the individual stick-slip displacements, average lines, parallel to the zero line, were drawn through the upper and lower extremities of the stick traces or sometimes through the midpoints. This admittedly arbitrary method serves to provide all the accuracy inherent in the data, and was moreover extremely simple and time saving.

It follows from Eq. (5) that when the stick begins, or slip back ends, above the zero line the kinetic friction coefficient is more than half the static value, and less than half when the slip back continues below the zero position. On the assumption, previously mentioned, that the slider will stick to the plate the first time its velocity falls to that of the table, this implication of Eq. (5) will be strictly true. If, however, the beginning of the stick trace represents only the end of a series of complete or partial oscillations, Eq.(5) loses its validity. As indicated in a previous paper[9], if the slider executes j complete oscillations and finally sticks to the plate in the i^{th} "quadrant"‡, the relationship between the frictional force F_k (assumed constant) and the initial restoring force, F_i, is governed by the inequality:

$$4j + 1 \leq \frac{F_i}{F_k} \leq 4j + 1 + 1. \qquad (6)$$

There appears to be no certain way of eliminating the ambiguity indicated by Eq.(6) except by stretching out the traces, as was described in a previous paper, and actually checking on the presence or absence of additional phases in the slip back cycle. Thus, for the high camera speed trace for Wood's metal sliding on babbitt, shown in Fig. 3, the kinetic friction coefficient obtained on applying Eq.(5), and taking for y_a the actual minimum, is 0.25, whereas the value 0.74 is obtained if for y_a the end of the slip or beginning of stick is used. In fact, it can be shown that if there is a single minimum between the beginning and end of the slip the true equivalent constant kinetic friction, f_k, will be given by:

$$f_k = k\left(\frac{y_b + y_a}{4}\right) = \frac{f_s - f_{ko}}{2} , \qquad (7)$$

where f_{ko} is the value calculated by Eq.(5) with the presence of the minimum ignored. Hence while the error thus made in f_k, i. e. $f_{ko} - f_k$, will be small for $f_s/f_{ko} > 2$, it may be quite large if $f_s/f_{ko} < 2$, as it is in the above example. This latter situation, however, has been found to occur only in the case of the example actually cited, namely Wood's metal on babbitt, among all of the 34 different metal combinations for which stretched out, or high camera speed, traces were made. No other of the 18, for which $f_s/f_{ko} < 2$, had an intermediate minmum. Among the 16 combinations for which $f_s/f_{ko} > 2$, only 4, namely tin and Wood's metal on brass and steel showed definite minima in the slip phase. Thus it appears from these statistical considerations that while the above discussed ambiguity in the kinetic friction coefficient determination may actually exist, it is quite unlikely to occur in the more serious cases where $f_s/f_{ko} < 2$—generally the hard metal combinations—and will occur only infrequently even when $f_s/f_{ko} > 2$, where the resulting error in f_k will be rather minor. Hence except in those cases where corresponding high camera speed traces were available and actually showed the presence of a minimum, no attempt was made to correct for the possibility of its existence.

Experimental Results

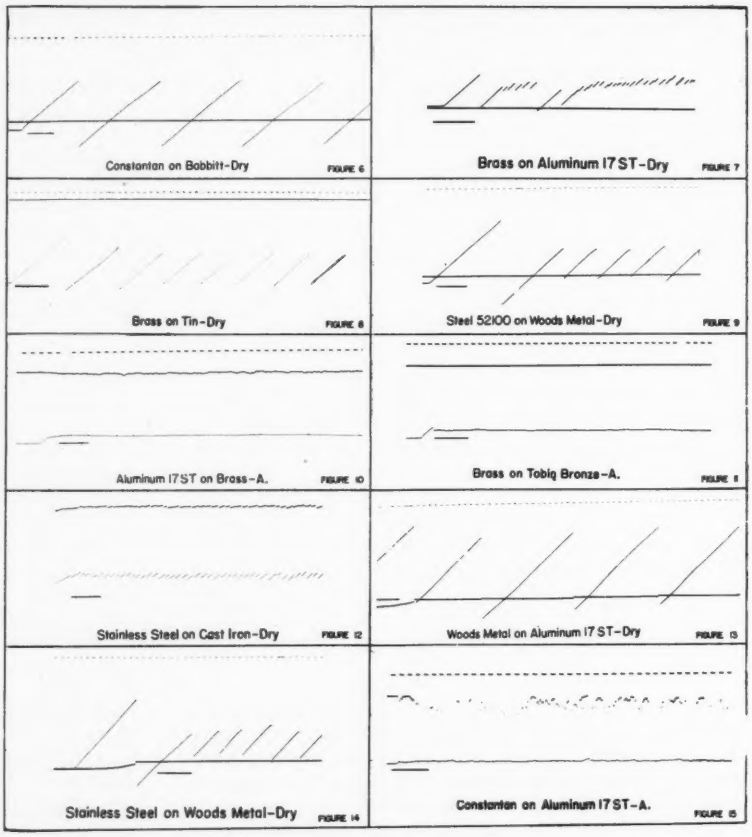
The numerical results are listed in Table 1. Here the numbers in parentheses after the names of the metals denote the Brinell hardness. The headings D, L, A, and S indicate that the contacts were dry, lubricated with Gulfpride 20, lubricated with Gulfpride 20 plus 3% oleic acid, and lubricated with a silicone. The upper number of each pair refers to the static friction coefficient, and the lower to the kinetic friction coefficient. The * indicates that the motion was continuous throughout all or a large part of the trace. In the former case no value for f_s is indicated, as the trace gives only f_k. In the latter, where the trace generally began with an initial stick, the amplitude of this stick was used in measuring f_s.

In Figs. 4 and 5 the frictional values (listed in Table I) are compared graphically. In each of the graphs of Fig. 4 the coefficient of friction for a given slider is plotted as ordinate, while the base plates in order of hardness are plotted as abscissae. This method of representing the data is entirely arbitrary. The graphs could equally well show the friction values for a given plate as the material of the slider is varied, as is done in Fig. 5. The lines connecting the points obviously have no significance and are inserted only as guides. It is of interest to note that the highest coefficients of friction are usually found when both metals are alike, and that the cast iron plate is most consistent in yielding low friction values. Although Bowden and Leben[4] and Ernst and Merchant[6] have previously indicated that a comparison of friction data on the

†While earlier work by the authors[9], as well as others, has shown that, in general, the kinetic friction does vary with velocity, the average, as here defined, provides a convenient basis for comparison for the purposes of statistical studies.

‡By a "quadrant" is meant a quarter cycle bounded by the zero line and a maximum or minimum amplitude.

Figs. 6-7-8-9-10-11-12-13-14-15. Stick-slip traces for various materials.



basis of melting point is probably of greater physical significance than one based on hardness, the latter method has been chosen here largely because the necessary data are more easily obtained. Bowden and Leben also observed that for various metals sliding on steel, the magnitude of the slip back increased as the melting point of the slider decreased. On the basis of the interpretation of the stick-slip behavior as given above the magnitude of the slip is a measure of the difference between the static and kinetic coefficients of friction. The fact that the difference between the static and kinetic curves for steel in Fig. 5 is smaller for the harder and higher melting point sliders than for the ones of lower melting point is tantamount to the observation that the slip back is smaller for the former.

In order to appreciate better the above numerical data and the subsequent discussion, it may be helpful to refer to the illustrative records reproduced in Figs. 6 to 15. In these traces, which are reproductions of samples chosen from the several series, the upper dashed lines are seconds timing marks to give an idea of the time scale for the stick-slip phenomena. On noting that the table speed was about 0.02 cm./sec., they also provide a distance scale. The heavy trace, generally lying below the stick-slip traces, indicates the voltage drop across the contact, which is proportional to the contact resistance. An increase in resistance is indicated by a deflection in a downward direction.

Fig. 6 shows a trace of constantan sliding on babbitt, without lubricant. It may be considered as illustrating a "regular trace", in which the slider displacements are quite uniform, and no "first stick anomaly" is present. The conductivity remains essentially the same during sliding as during sticking. Fig. 7, for brass sliding on 17ST aluminum, without lubricant, illustrates an "irregular trace", frequently obtained when both slider and plate are hard, and dry. Fig. 8, for brass sliding on tin, without lubricant, shows a typical "first stick anomaly" with a subsequent regular behavior. The first stick would clearly give a higher static friction coefficient than the later ones, but as it evidently indicates a sensitivity to the history of the contact, the more regular subsequent stick displacements have been taken as more representative of the friction behavior.

In Fig. 9, for SAE 52100 steel sliding on Wood's metal, without lubricant, may be noted a tendency for the stick displacements to curve appreciably before the slip back begins. This behavior is rather uncommon, but may be readily observed for hard metals sliding on Wood's metal, when dry, and also for Wood's metal sliding on tin or brass, when lubricated with Gulfpride 20 plus 3% oleic acid. It is caused by failure of the slider to stick fast to the moving surface. In other words, relative motion occurs between the slider and the plate and the friction is kinetic. Since the displacement during slippage is greater than for strict adhesion, this type of trace corresponds to the condition in which the coefficient of kinetic friction is greater than the static coefficient.

A quite uniform motion, with no stick phase, is illustrated by Fig. 10 obtained with aluminum alloy sliding on brass when lubricated with Gulfpride 20 plus 3% oleic acid. For the same lubricant, brass on bronze gives an initial stick followed by a continuous sliding motion, as shown in Fig. 11. Continuous sliding is generally considered to be desirable from the standpoint of wear. Photomicrographs of the track of the slider indicate that considerable tearing of the surfaces, accompanied by loss of metal and wear, occurs when the slider sticks and is pulled away again.

When the contact resistance is not strictly constant, its variation may be of several types. Generally, the resistance increases during slip, as shown in Fig. 12 for 304 stainless steel sliding on cast iron, dry, where it may also be noticed that the resistance falls during the stick phase. However, for Wood's metal sliding on 17ST aluminum, dry, the reverse is observed, as may be seen from Fig. 13. The conductivity traces also serve to confirm the difference between the type of contact which may obtain in the case of the first stick as compared to subsequent sticks. This is illustrated by the decreasing resistance recorded for the first stick of stainless steel sliding on Wood's metal, when dry, reproduced in Fig. 14. Finally, it is of interest to note the very violent fluctuations in contact resistance, in spite of rather smooth continuous sliding, frequently observed when an oiliness agent is used in the lubricant for hard metals in relative motion, as exemplified by Fig. 15 for constantan sliding on aluminum alloy.

Discussion

In view of the great mass of data made available by the 484 records obtained in the survey, a statistical analysis was made. The basic correlation parameter which was used in classifying the data was the metal hardness. This choice was not based on any naive notion that the friction behavior is determined exclusively by the hardness of the surfaces in contact. The importance of the melting point has already been noted. Rather, the hardness provided a convenient and simple parameter, with a rather large range of variation among the metals studied. Moreover, as the surfaces were all treated similarly, the roughness was probably of the same order throughout, and hence should not of itself play such a major role in the type of survey undertaken. Again, not to overemphasize the significance of the exact values of the hardness, the metals were divided into only two groups—soft and hard. The former included those with brinell hardness of 24 or less, namely: tin(6), Wood's metal(12), lead(16), babbitt(24) and zinc(24). The latter included copper (70), constantan(82), Tobin bronze(104), cast iron (113), 17ST aluminum(116), brass(119), stainless steel(143), and SAE 52100 steel(187).

The characteristic features which were subject to the statistical analysis were: regularity of trace, presence or absence of an initial stick greater than the subsequent ones, the value of the ratio f_s/f_k, and the nature of the conductivity variation throughout the records. The results are given in Table II.

It will be seen from Table II that there is a sharp difference in trace character between pairs of dry contacts in which at least one of the metals is soft, and that in which both are hard. The former, as a rule, give regular traces whereas the latter generally lead to irregular stick-slip behavior. Recognizing the purely statistical nature of these observations—as well as the others listed in Table II—and the occurence of a number of exceptions, it is nevertheless pertinent to formulate physical pictures whereby the observed behavior may be at least rationalized. One such is the suggestion that when one of the surfaces is soft the true contact area may be large enough, due to plastic flow, to average out the microscopic surface irregularities and provide a statistically uniform contact region as the slider moves across the plate. When both metals are hard local point contacts will tend to persist and the fluctuations in microscopic surface topography will lead to an irregular stick-slip motion.

According to this picture, in the case of hard metal combinations, point to point contact generally predominates and irregularities in microscopic surface topography will lead to an irregular stick-slip behavior. In the case of soft metals, however, the friction reactions are determined largely by body rather than surface properties. Thus, when a soft metal sildes on a hard surface, the former undergoes plastic deformation and bonds tightly to the hard surface. Subsequent motion then involves a shearing within the body of the soft metal, which is weaker than the intermetallic bond, and thus may lead to the frequently observed soft metal wear. As the bulk shear strength should be a well defined property, regularity in the stick-slip behavior is to be anticipated. Likewise, hard sliders will tend to pierce the surfaces of soft plates. Relative motion will then be resisted by the plastic flow or "ploughing" resistance of the soft metal, which should again reflect a characteristic of the bulk metal and hence lead to a more uniform behavior. When both metals are soft, the inter-metallic junction is apparently generally stronger than the bulk shearing strength of the softer of the two, and regular traces are again the rule. When the same soft metal is used for slider and plate, the outcome of the competition between the strength of the

Plate / Slider	Tin (6) "232"				Wood's Metal (12) "65.5"				Pb (16) "327"				Babbitt(24) "∿ 300"				Zn (70) "1083"				Tobin Bronze (104) "∿ 1050"				Cast Iron (113) "∿ 1200"				Al (116) "340"				Brass (119) "∿ 940"				Stainless Steel (143) "∿ 1500"				SAE 52100 Steel (187) "∿ 1500"			
	D	L	A	S	D	L	A	S	D	L	A	S	D	L	A	S	D	L	A	S	D	L	A	S	D	L	A	S	D	L	A	S	D	L	A	S	D	L	A	S	D	L	A	S
Sn(6)	87	77		74	76	28	31	33	70	38	30	33	130	45	30	23	80	67	43	70	77	55	31	29	50	26	22	28	74	34	24	23	70	27	30	80	94	15	31	26	84	31	17	24
"232"	75	37	68	74	30	9	12	13	35	19	18	18	45	19	12	16	32	25	16	40	31	22	15	16	24	18	14	17	31	24	18	19	28	13	13	63	44	8	13	15	38	19	11	19
Wood's Metal(12) "65.5"	65	31	22	29	74	40	34	32	66	48	46	40	119	39	19	19	79	27	22	33	67	30	18	30	58	26	23	28	101	29	25	27	57	16	18	25	80	13	15	25	95	19		26
	25	12	13	13	31	24	12	14	36	17	20	19	71	15	12	16	26	16	13	16	26	18	11	13	23	13	12	16	41	18	20	20	23	12	13	13	28	9	14	14	31	15	16	14
Pb (16) "327"	79	34	28	49	80	61	53	32	115	45	33	53	115	41	31	33	86	33	37	40	87	43	27	28	39	29	19	24	93	19	37		95	21	29	30	93	33	24	23	95	33	26	30
	41	18	18	27	30	30	19	11	104	26	22	27	93	18	15	23	39	19	23	29	43	17	13	23	23	16	15	21	40	16	21	28	36	12	11	23	31	16	18	20	46	23	19	17
Babbitt(24) "∿ 300"	102	44	30	36	53	32	23	24	86	43	47	39	96	64	24	21	78	36	22	60	68	20	18	26	52	19		23	90	31	20	28	86	19	21	30	89	16	18	25	80	23	18	27
	77	16	15	15	25	11	12	14	50	19	19	18	51	37	12	15	55	19	13	29	21	11	12	13	23	16	15	21	31	21	16	20	32	12	12	18	31	11	17	21	34	8	15	15
Zn(24)	117	35	31	43	54	32	29	32	75	46	41	42	67	28	19	23	74	27	18	36	45	20	20	32	40	23	36	31	62	19	16	26	53	23	35	22	62	22	19		77	38	29	36
"419"	48	15	17	17	30	12	14	23	51	19	20	21	24	10	13	19	56	15	15	29	37	13	12	18	36	16	19	26	51	12	14	23	39	14	12	15	43	11	15	28	64	23	19	12
Cu(70)	88	46	51	48	51	30	31	28	97	49	45	39	83	44	26	23	129	40	15	32	54	26	22	38	38	23	21	25	84	22	16	52	44	23	21	42	46	17	24		69	25	20	36
"1083"	32	23	15	23	32	16	14	24	66	23	21	20	30	19	13	15	129	19	15	29	46	20	13	27	37	18	20	23	68	20	16	43	31	20	14	21	37	14	18	25	51	22	17	25
Constantan (82) "1280"	54	43	43	39	54	21	38	50	120	47	38	43	79	33	30	27	125	20	12	70	41	19	14	37	37	20	19	30	67	39	14	59	38	21	19	35	64	16	26	38	46	33		25
	26	22	16	17	31	11	23	15	108	25	21	25	27	17	12	17	125	14	12	56	34	14	11	30	31	13	18	27	60	27	14	51	30	18	11	30	55	12	18	34	38	26	20	20
Al (116)	99	48	30	33	51	28	33	28	87	50	42	35	74	28	37	37	64	16		42	57	21		34	35	22		39	58	18		55	49	18		33	55	17	17		68	26	21	50
"∿ 340"	34	19	24	20	31	16	16	24	68	25	16	23	26	13	17	23	53	16	15	40	47	15	11	31	29	17	12	37	47	17	15	44	43	15	12	23	44	13	16	50	52	19	18	50
Brass (119)	99	45	34	47	52	21	28	21	91	42	43	38	72	38	23	31	92	25	25	40	45	20	15	34	36	18	16	27	62	20	27	30	54	18		23	59	19		31	50	26	19	28
"∿ 940"	31	19	16	16	29	10	12	18	67	23	27	19	27	14	12	15	65	17	17	32	38	16	11	31	33	16	13	23	58	18	17	29	44	14	9	23	55	13	15	26	44	21	18	14
Stainless Steel (143) "∿ 1500"	59	32	29	27	46	24	28	28	72	34	17	40	70	21	23	21	66	23	31		45	20	23	36	32	20		31	75	20	20	53	36	18	14	20	80	21	20	35	43	33	22	26
	27	19	18	17	30	12	18	20	48	20	13	26	24	13	14	18	50	20	16	35	39	14	15	29	28	16	13	34	66	19	15	47	30	15	14	20	74	17	19	32	36	28	17	17
SAE 52100 Steel (187) "∿ 1500"	57	36	40	35	51	25	42	43	80	42	19	43	76	24	26	31	37	25	16	35	40	20	19	37	31	20	17	40	80	18		58	55	18		34	27	19	23	51	50	43	20	29
	28	22	20	18	30	12	23	16	55	21	12	22	27	13	15	22	23	17	15	35	31	15	15	28	26	15	16	36	70	17	16	50	42	17	15	29	23	15	19	16	28	31	16	27

Table I. Friction coefficient X100 for various metal combinations.

TABLE II—STATISTICAL ANALYSIS OF STICK-SLIP TRACES

	Dry	Gulfpride 20	Gulfpride 20 + 3% Oleic Acid	Silicone
Soft on Soft (20 pairs)				
Regularity of Trace	85% Regular; None continuous	All Regular; 1 continuous	All Regular; 2 continuous	70% Regular 1 continuous
Show First Stick Anomaly	60%	75%	95%	85%
$f_s/f_k \geq 2$	70%	90%	65%	45%
Conductivity Variation	Not detectable in 80%; slight breaks in remainder	Detectable in only 1	Detectable in only 1	Not detectable in 85%; small in remainder
Soft on Hard (35 pairs)				
Regularity of Trace	85% Regular; None continuous	70% Regular; 10% continuous	35% Regular; 25% Irregular	46% Regular; 20% continuous
Show First Stick Anomaly	65%	70%	70%	60%
$f_s/f_k \geq 2$	70%	30%	20%	11%
Conductivity Variation	Detectable in 40%	Large in 30%; small or not detectable in 30%	Not detectable in 75%; remainder small	Not detectable in 60%; Large in 14%
Hard on Soft (24 pairs)				
Regularity of Trace	92% Regular; None continuous	All Regular	75% Regular; 25% continuous	50% Regular; 1 continuous
Show First Stick Anomaly	67%	62%	All but 1	75%
$f_s/f_k \geq 2$	50%	80%	62%	33%
Conductivity Variation	Small in 38%; not detectable in remainder	Large in 16%; small or undetectable in remainder	Not detectable in 92%; small in 8%	Not detectable in 62%; Large in 4
Hard on Hard (42 pairs)				
Regularity of Trace	90% Irregular; 3% Regular; 7% continuous	55% Regular; 1 continuous	None Regular; 80% continuous	2 Regular; 6 partly continuous, remainder irregular
Show First Stick Anomaly	20%	40%	50%	12%
$f_s/f_k \geq 2$	0	1	1	5%
Conductivity Variation	Large in 20%; small in 30%; not detectable in remainder	Large in 33%; Small in 25%	Large in 50%; Small in 25%	Not detectable in 55%; Large in 20%

interface bond and the internal bulk shearing strength is not so easy to predict. Thus, the former seems to provide the least resistance for tin and lead, and an irregular continuous type of motion is observed, whereas babbitt and Wood's metal apparently form a stronger interface bond and give rise to regular traces.

Observations made on the sliding surfaces themselves seem to be consistent with this explanation. If the soft, low melting point, sliders are watched carefully, flow can often be detected just before the slip begins and slider material will be smeared on the plate. The transfer of metal has been noted frequently even for copper sliding on steel and may be an indication of too great a load. On the other hand no well defined method has been adopted for specifying the maximum permissible load beyond the implication that the force of friction should remain proportional to the force pressing the surfaces together. In order to test this point the load was frequently varied. In all cases in which observations were made the ratio of frictional force to applied load was essentially constant.

It is possible to correlate this mechanism with the observations on the "first stick anomaly". Thus, when both metals are hard, and plastic deformation is restricted to surface shearing, the first stick may be expected to be equivalent to the subsequent sticks, and the "first stick anomaly" should be absent. When, however, a hard metal slides on a soft plate it may be anticipated that the degree to which the former sinks into the latter will depend on the duration of the contact. As in the later sticks the time of contact is only a few seconds, as compared to several minutes for the first stick, the latter will give rise to a greater initial ploughing resistance and hence a "first stick anomaly". The general occurrence of the anomaly when soft metals slide on a hard base may also be explained in terms of the time difference involved in the duration of the first metal-to-metal junction and those in later sticks.

The role played by the metal surfaces themselves in determining the type of sliding for a lubricant containing an oiliness agent is shown by the fourth column in Table II. While two out of twenty traces for soft on soft metals showed continuous sliding, twenty-five percent were continuous for hard on soft, forty per cent for soft on hard, and eighty per cent for both surfaces hard. This greater probability for the occurence of continuous sliding with the hard, high melting point, metals may apparently be explained on the basis of the mechanism of sliding proposed above. In the case of the hard metals the oiliness agent will need only to modify the adhesive forces as the slip already occurs at the junction of the metals. Continuous sliding may occur because the lubricant reduces the coefficient of static friction to a value equal to or less than the kinetic coefficient. This, however, is not a necessary condition. The more uniform stick-slip motion of the soft metal combinations seems again to imply that shearing takes place within the metal. Any decrease in friction due to an oiliness agent must then be due either to a reduction in area sheared or in the shearing modulus. Experiment[10] seems to indicate that both are important factors. An alternative description of the phenomenon is that slip now actually takes place between the metals, the regularity being due to the statistically large number of contact points. The oiliness agent would then tend to reduce the sliding resistance though not as effectively as in the case of the hard metals.

In all columns of Table II may be noted the

(*Continued on page* 103)

SIGNIFICANCE OF TESTS AND SPECIFICATIONS FOR GREASES *

by Gus Kaufman

The Texas Company
Technical and Research Division
New York, N. Y.

Mr. Kaufman received his early education in Houston, Texas, and received the degree of Bachelor of Science in Chemical Engineering from the Rice Institute in 1924.

Since then he has been connected with The Texas Company largely in the Technical and Research Division. He was placed in charge of grease research at the Port Arthur, Texas. Laboratories and later at the Beacon, N. Y., Laboratories. In 1941, he transferred to the New York offices as Staff Technologist and then to his present position as Assistant to the Manager of the Technical and Research Division. He is the author of many patents and publications on lubricating greases, cutting oils, gear lubricants, and allied subjects.

He is a member of Tau Beta Pi, American Chemical Society, American Institute of Chemical Engineers, and is serving on many important committees of a scientific and technical nature.

The purpose of this paper is to describe the most common and frequently used tests for lubricating greases, their significance and actual value in specifications. When test methods are mentioned, naturally the ones most commonly used and referred to are those recognized by the American Society for Testing Materials. In the "ASTM Standards on Petroleum Products—Committee D-2—1947" are listed over a dozen individual items for use in testing lubricating greases. It would appear on first thought that merely including some or all of these tests in a specification would insure a product having the desired characteristics and serve as a check on uniformity. Actually, as this paper will show, the opposite is the case; that is, the above tests will not insure a product of the desired performance characteristics unless performance tests of suitable reproducibility have been included in the specification. Many papers have been presented on performance test methods and not even a small percentage of these has been recognized as being suitably reproducible or useful for specification purposes. It is obvious, therefore, that considerably more fundamental information on lubrication is necessary before simple and inexpensive performance tests can be devised. In any case, no simple performance tests exist today, at least none which has any significant recognition. There may be some isolated exceptions to this statement, but, in general, suitable performance tests are not available to the average laboratory. As a matter of fact, the larger research organizations do not depend upon simple laboratory tests or simple laboratory performance tests. Before a product is marketed it must pass longtime simulated service tests under accurately controlled conditions in the laboratory, followed by extensive field tests in field equipment over the severest ranges of conditions of operations and over extended periods of time.

Let us consider the more common laboratory tests run on lubricating greases and their real significance:

Consistency

The most widely used test for lubricating greases is consistency. This test according to the ASTM Method D217-47T is run by determining the depth of penetration of a cone of prescribed dimensions which is allowed to drop into the grease. It merely measures how hard or how soft a grease is, by measuring how far a cone of arbitrary size and shape penetrates under arbitrary conditions. In order to have a common ground on which to describe the consistency of a grease, the National Lubricating Grease Institute has developed a classification based on the ASTM penetration of a worked sample. The classification comprises seven grades identified as NLGI No. 0 through No. 6. Each grade has a range of thirty points in penetration, and with a fifteen point spread between grades. The latter means that any product falling between two grades meets no classification, and, therefore, is ruled out even though it may be a very good lubricating grease.

Although the NLGI classification gives an indication of the hardness or the softness of grease, it cannot be used to indicate the performance of grease. This is emphasized by the following statement made when the NLGI classification was considered[1]:

> "It should be pointed out that this classification in no manner indicates quality of product and in no way indicates what the chemical and physical characteristics of a grease may be other than the consistency and the standard grade for that consistency."

The following excerpt from a previous paper[2] by the author amplifies this point:

> "When a new or improved grease is developed, its successful limits of operation are not limited to a consistency range of only thirty points. In most cases during the development of the product it was found to work satisfactorily over a much wider consistency range than thirty points; for example, fifty points or one hundred points, or even two hundred points in ASTM penetration. The consistency of the final grease is limited to the required NLGI thirty points primarily for greater uniformity and because of mechanical or operational limitations. For example, the particular grease gun available might not handle a wider range of consistency or the particular motor might not have sufficient power to turn if a harder-consistency product were used. The fact remains that the same grease functions from a lubrication standpoint over a wide range of consistencies. Therefore, reasonable limits for consistency are all that are necessary."

Experimental as well as practical data have proved that consistency may play only a minor role from a

*Paper presented before Dayton Section of A.S.L.E.

performance angle, and as regards leakage tendency, more important considerations are the texture of the grease, tendency of the grease to entrain air, tendency to expand due to loss of volatile constituents, etc. The following tabulation[2] points this out:

CONSISTENCY VS. LEAKAGE

	GREASE C	GREASE D	GREASE E
ASTM Penetration			
Unworked	255	250	265
Worked	430	275	280
Leakage from Ball Bearing Operating at 1750 r.p.m.	None	35-40%	None
Penetration on Used Grease	Too Soft*	Only slight softening	Only slight softening

* Penetration more than 420.

It is emphasized, therefore, that the consistency of a grease, whether determined by the ASTM penetrometer or other means, cannot be used as a criterion of performance, and at best is of value only in controlling the uniformity of manufacture.

Pressure Viscosity

More recently considerable attention has been directed toward the use of the pressure viscometer for testing lubricating greases and already there are indications that this particular property and this particular test are being misused. In simple words, and at best, all that a pressure viscosity of a grease will tell one is that it will take so much pressure to pump a grease through a pipe of given dimensions for a given distance. Some have attempted to infer that the pressure viscosity of a grease is a measure of its heat resistance; that is, the higher the viscosity at elevated temperatures, the greater its heat stability. Actually just the opposite may be the case. In the first place, in determining the pressure viscosity of a grease, whereby the pressure required to pump the grease through a specified orifice at specified rates of shear is determined, the grease is subjected to the particular temperature under which the viscosity is determined for only a very short period of time, whereas a grease must function for hundreds, or even thousands of hours, at elevated temperatures. If the pressure viscosity value at elevated temperatures is high, it does not mean that the grease is better; it merely means that it will take more pressure to force the grease through the orifice at the elevated temperatures. In fact, one plausible explanation for an increase in pressure viscosity with temperature would be the tendency of the grease to separate out tiny particles of soap, tending to clog the orifice. Therefore, pressure viscosities cannot be used as a criterion for performance.

Dropping Point

Another very commonly used test for lubricating greases is the ASTM dropping point. Prior to the adoption of this method some several dozen methods were studied and considered. For example, the review by Georgi[3] lists some ten different types of methods in use even though the ASTM Standard Method of Test for Dropping Point of Lubricating Grease—ASTM D-566-42 has more general acceptance. In the latter, a tiny cup with bottom opening is filled with grease and heated at a specified rate. The point at which one drop detaches itself from the remainder of the grease in the cup is considered the dropping point. In using this method some have drawn the erroneous conclusion that the higher the dropping point, the greater the heat resistance, in spite of the fact that the ASTM method specifically states: "It should not be considered as having any bearing on service performance." The following specific case will point out the futility of using dropping point as a criterion of performance.

In the course of some research work a grease was prepared from a very unusual fat stock, actually a very cheap fat. The dropping point values were extremely high since the testers reported that the dropping point was beyond the scale of the thermometer; that is, over 580 F. This seemed surprising since on the basis of the raw materials used, the dropping point should have been, if anything, lower than similar greases made with the usual fats. The reason for this anomolous behavior was soon discovered. The dropping point method calls for a specified slow rate of heating. During the heating period it was noticed that the grease changed in color and texture, becoming darker and darker and finally carbonizing. In other words, the grease oxidized completely and charred, resulting in the unusual dropping point value.

Oxidation Stability

The Norma-Hoffman Bomb Oxidation Test has been the most widely used method for accelerating the oxidation of lubricating greases. It has now been accepted as a tentative method by ASTM identified as "Tentative Method of Test for Oxidation Stability of Lubricating Greases by the Oxygen Bomb Method—ASTM Designation D-942-47-T." While this method does give a good means for accelerating oxidation, the following excerpts from the method point out the importance of understanding the significance of the Test:

"This method describes a test for determining the resistance of lubricating greases to oxidation when stored under static conditions for long periods of time, as for example, thin coatings on anti-friction bearings and all motor parts, etc. It is not intended for the prediction of the stability of greases under dynamic service conditions, nor is it intended for the prediction of the stability of greases stored in commercial containers."

The method itself is very simple:

"The sample of grease is oxidized in a bomb heated to 210 F and filled with oxygen at 110 PSI. Pressure is observed and recorded at stated intervals. The degree of oxidation after a given period of time is determined by the corresponding decrease in oxygen pressure."

Regarding the significance of the test results, it has been found that most greases which have poor resistance to oxidation, such as an ordinary uninhibited lime soap cup grease, may give values of the order of 25-50 pounds pressure drop in 100 hours under the above conditions of test. It has been found that bearings packed with these ordinary cup greases will show a tendency toward seizure in less than three months' storage. As opposed to this, good greases will show pressure drops of the order of less than ten pounds after 100 hours, and such grease will protect bearings satisfactorily for several years. This then is a general picture of the significance of the test. However, there are some very important exceptions. For reasons not entirely understood at present, lubricating greases made with residual oils, such as the usual wheel bearing greases, have excellent oxidation resistance in bearings, yet show relatively high values in the bomb oxidation test. As another instance, when the Norma-Hoffman Bomb Oxidation Test was first developed, the evaluations were carried out at lower temperatures than the presently specified 210 F; for example, 175 F. One product on which considerable field experience had been obtained gave excellent values by the bomb oxidation test at 175 F, yet produced variable and usually high pressure drops at the presently specified 210 F.

However, a bearing packed with this grease has now been in storage for eight years, and the bearing is still satisfactorily protected. These exceptions, however, do not in any way mean that the bomb oxidation test does not in most cases differentiate between most good and bad greases as regards oxidation resistance, but they do point out the care which must be used in the conclusions drawn.

Separation Tests

The matter of oil separation in grease is a good instance where the importance attached to a typical property of a grease is completely out of proportion to its real significance. The many methods which have been devised, and are being devised, are a good indication of the difficulties in developing a good method, but the main question is what do the results mean? There is insufficient space here to cover the various methods in use, but regardless of the method, the results are usually reported in the percentage of oil separating after specified periods of time, at specified temperatures, using specified containers (sometimes under pressure). Here again some assume that the less the oil separation, the better the grease. In the first place, no reputable grease manufacturer will offer a product which has deleterious oil separation. However, it is a general consensus that a small amount of oil bleeding is not only desirable but of considerable value since the presence of the free oil insures immediate lubrication. In fact the consulting engineer of one of the larger antifriction bearing manufacturers once stated at an open meeting of industry and government representatives: "I would not have a grease which did not separate some oil."

It seems only fair to give some thought to the meaning of oil separation. In a container, say a 400-pound drum, the presence of even such a large amount as five pounds of oil will produce a negligible change in the composition of the remainder of the grease. Going a step further, let us assume that a product containing 20 per cent soap has separated as much as 10 per cent oil by the particular test method used. The final product after this separation test would show only a very slight increase in soap content; that is, less than 2 per cent. Therefore, considerable care must be used in interpreting oil separation results. A small amount is almost always beneficial.

Evaporation Test

The ASTM have now published for information[4] A Proposed Method of Test for Evaporation Loss of Lubricating Greases and Oils. The method consists in placing a specified amount of grease in a cell which is placed in a bath at 210 F. for a specified period of time (23 hours), and the loss in weight determined. This method is primarily intended for low temperature greases made from extremely low viscosity oils. It does give an indication of the loss to be expected from evaporation under the stated conditions. It should be remembered that the method is a static method and that under dynamic conditions different results will necessarily be obtained. Here too it should be emphasized that even a high loss changes the composition of the grease only slightly and may still result in a grease having entirely satisfactory lubrication characteristics although impairing its low temperature characteristics. What the values for evaporation loss mean in terms of practical service can only be determined by correlation. Therefore, here too the method may be all right as an

indication, but does not give the final answer from a practical standpoint.

Water Susceptibility

This property of a grease was given considerable importance during the war primarily because of amphibian operations wherein the lubricant might be subjected to large quantities of water. Many methods have been suggested. It seems, however, that before considering a method of test for the so-called water susceptibility the question which should be asked is "Is water susceptibility or water resistance wanted?"

A specific case in point was the contention of some during the war that a water insoluble grease was necessary for wheel bearings, particularly in amphibian equipment. The contention was that the currently government approved products for this purpose (U. S. Army Specification 2-108) permitted greases which tended to emulsify with water, and from this it was inferred that such greases would be washed out. However, the extensive tests by the Army at Vero Beach, Florida, under the most severe conditions proved just the opposite. In fact, the so-called "water insoluble" greases were considered unsatisfactory due to rusting, whereas the so-called "water soluble" sodium soap products lubricated entirely satisfactorily and protected the bearing parts from rusting.

Miscellaneous Physical Tests

Many other tests have been suggested for greases, such as copper corrosion tests and extreme pressure tests. These will not be covered in detail except to mention that no acceptable methods have been developed and the real criterion of the situation is the actual field performance of the products. A grease can be made with extremely high extreme pressure characteristics; for instance, beyond the capacity of most of the extreme pressure machines; yet it may be entirely unsatisfactory due to corrosiveness, etc. By having products which have been proved under field conditions, these pitfalls are avoided.

Chemical Analyses

ASTM Method D-128-47 is the generally accepted method for the analysis of grease. The work of Technical Committee G has resulted in several improvements in the method which are now incorporated in the method. In spite of the very excellent methods worked out to identify certain constituent groups in a grease, such as soap, fat, petroleum oil, free fatty acid, glycerin, etc., it is important to remember that these merely identify the constituents and the amounts present, but

(*Continued on page* 94)

Program

Fourth Annual Convention and Exhibit

THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

Mon., Tues., and Wed., April 11 - 12 - 13, 1949

HOTEL STATLER (formerly Hotel Pennsylvania), NEW YORK CITY

MONDAY, APRIL 11, 1949

9:00 A. M.—REGISTRATION—18th Floor
Hotel Statler
Official Opening of Exhibits

11:00 A. M.—GENERAL SOCIETY BUSINESS MEETING
Chairman: W. E. Campbell
President's Message—G. L. Sumner
Secretary's Report to Members—W. F. Leonard

12:30 P. M.—WELCOME LUNCHEON
GEORGIAN ROOM
Speaker: P. W. Swain, Editor of POWER
Chairman: C. M. Larson
Welcome to New York by the Honorable William O'Dwyer, Mayor of the City of New York.

2:15 P. M.—OPENING TECHNICAL SESSION
MEETING ROOM NO. 1
Chairman: O. L. Maag
GREASE SYMPOSIUM
SESSION 1

"Development of Grease Lubricating Systems"—A. J. Jennings, The Farval Corp.

"Greases—Their Uses in Anti-Friction Bearings"—J. H. Gustafson, Marlin-Rockwell Corp.

"Grease Lubrication in the Machine Tool Industry"—E. R. Harris, Alemite Sales Div., Stewart-Warner Corp.

"Grease Application to Mining Machinery"—M. B. Lawton, Lincoln Engineering Co.

"Use of Grease in the Steel Industry"—L. W. Deutsch, Trabon Engineering Corp.

"Anti-Friction Bearings Pay Dividends on Textile Machinery"—C. A. Berg, The Fafnir Bearing Co.

"A-B-C's of Lubricating Grease"—G. W. Miller, Battenfeld Grease & Oil Corp.

Exhibits Open to 10:00 P. M.

TUESDAY, APRIL 12, 1949

9:30 A. M. to 12:00 Noon
MEETING ROOM NO. 1
Chairman: R. W. Flynn
SESSION 2-A

"Railway Lubrication"—W. M. Barr, Union Pacific Railroad Co.

"A Survey of Centralized Lubrication in the Textile Industry"—W. A. Newell, Textile World.

9:30 A. M. to 12:00 Noon
MEETING ROOM NO. 2
Chairman: D. D. Fuller
SESSION 2-B

"Improved High Speed Roller Bearings"—D. F. Wilcock, General Electric Co.
"Dynamically Loaded Bearings"—M. C. Shaw, Mass. Institute of Technology.
"The Dissipation of Frictional Heat"—H. Blok, Royal Dutch Shell, Delft, Holland.

2:15 P. M. to 5:00 P. M.
MEETING ROOM NO. 1
Chairman: B. G. Symon
SESSION 3-A

"What Lubrication Means to Management"—G. M. Read, E. I. du Pont de Nemours Co.

GENERAL DISCUSSION AND AUDIENCE PARTICIPATION.

Exhibits Open to 6:00 P. M.

2:15 P. M. to 5:00 P. M.

MEETING ROOM NO. 2

Chairman: E. H. Erck

SESSION 3-B

"N. A. C. A. Friction Studies of Lubrication at High Sliding Velocities"—E. E. Bisson and R. L. Johnson, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory.

"Progress in Instrument Lubrication"—H. Gisser, Pitman-Dunn Lab., Frankford Arsenal.

"Non-Flammable Hydraulic Fluids" — C. M. Murphy and W. A. Zisman, U. S. Naval Research Laboratory.

TUESDAY, APRIL 12, 1949

7:30 P. M.—ANNUAL BANQUET

GRAND BALLROOM

Toastmaster: B. H. Jennings

Speaker: E. L. Shaner, Chairman of the Board, The Penton Publishing Company, Editor-In-Chief, Steel Magazine

Introduction of New Officers

Presentation of Awards:

Alfred E. Hunt Memorial Medal

Walter D. Hodson Award

(Dress Informal)

WEDNESDAY, APRIL 13, 1949

9:30 A. M. to 12 Noon

MEETING ROOM NO. 1

Chairman: J. J. Scott

SESSION 4-A

"Service Degradation and Maintenance of Petroleum Oils"—C. J. Egger, Bowser, Inc.

"Preventing Accidents by Proper Lubrication"—W. E. Montgomery, Kenneth B. S. Robertson, Ltd.

"Hydrodynamic Aspects of Porous Bronze Bearings"—T. B. Howe, Sperry Gyroscope Co.

9:30 A. M. to 12 Noon

MEETING ROOM NO. 2

Chairman: A. J. Zino, Jr.

SESSION 4-B

"Direct Measurement of Piston-Ring Friction in an Internal Combustion Engine"—J. C. Livengood, Mass. Institute of Technology.

"Some Aspects of Diesel Cylinder Lubrication"—E. B. Watson, Cornell University.

"The Role of Cutting Fluid as a Lubricant"—K. E. Bisshopp, E. F. Lype and S. Raynor, Armour Research Foundation.

2:15 P. M. to 5:00 P. M.

MEETING ROOM NO. 1

Chairman: M. L. Langworthy

SESSION 5

LUBRICATION FORUM

Round table discussion of lubrication problems and their solutions.

4:30 P. M.—BUSINESS MEETING OF OFFICERS AND DIRECTORS, A.S.L.E.

Exhibits Open to 6:00 P. M.

This program has been carefully planned to be of real value to men who design, operate and maintain today's highly complex industrial machinery. The American Society of Lubrication Engineers, its officers, and the New York Convention Committee extend a cordial welcome to all those interested, to attend the technical and social functions listed above.

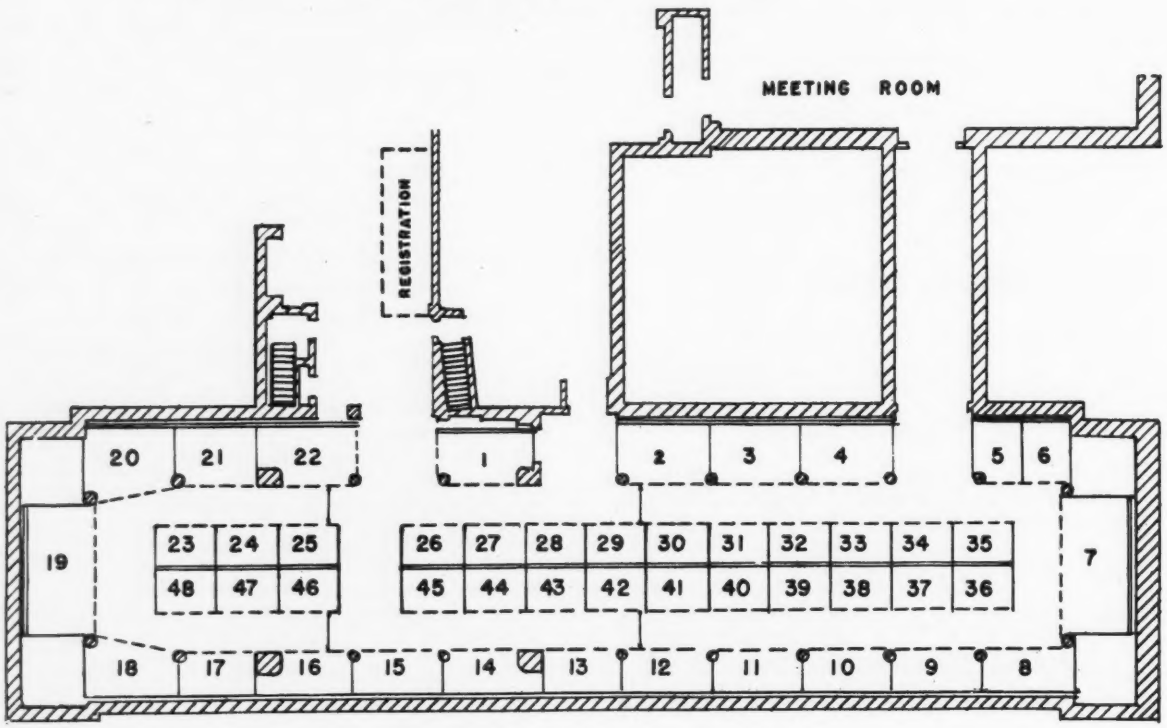
Registration fees: Members, $1.00; Non-Members, $3.00, of which $2.00 may be credited towards membership dues in the Society if application is made within thirty days, after the Convention.
For news of the New York Convention Committee activities and proposed entertainment, see News of the Sections, page 93.

The Second Annual Exhibit Devoted Exclusively To Lubrication

- - 3 IMPORTANT DAYS - -

APRIL 11 - 12 - 13, 1949

HOTEL STATLER (formerly Pennsylvania), NEW YORK CITY



FLOOR PLAN AND EXHIBITORS

LUBRICATION DEVICES

	Booth No.
Bijur Lubricating Corp.	10
Eagle Mfg. Co.	38
Farval Corp., The	19
Gits Bros. Mfg. Co.	26-27
Gray Co., Inc.	1
Houghton & Co., E. F.	18
Lincoln Engineering Co.	16
Madison-Kipp Corp.	8
Manzel, Inc.	4
Norgren Co., C. A.	5
Nugent & Co., Inc., Wm. W.	17
Stewart-Warner Corp.	34-35
Trabon Engineering Corp.	2

TESTING

Gerin Corp.	15
Precision Scientific Co.	9

Exhibition Hall—18th Floor

April 11 .....9 A. M. to 10 P. M.
April 12, 13 .....9 A. M. to 6 P. M.

LUBRICANTS AND CUTTING FLUIDS

	Booth No.
Carbide & Carbon Chemicals Corp.	3
Cincinnati Milling Machine Co.	41
Cities Service Oil Co.	37
Gulf Oil Corp.	32-33
Hodson Corp., The	29
Shell Oil Co., Inc.	7
Socony-Vacuum Oil Co., Inc.	44-45
Stuart Oil Co., D. A.	28
Sun Oil Co.	22
Swan-Finch Oil Corp.	20
Texas Co., The	11
Tide Water Assoc. Oil Co.	25
Dow Corning Corp.	36

FILTRATION

Bowser, Inc.	12
Commercial Filters Corp.	46
De Laval Separator Co.	30
Nugent & Co., Inc., Wm. W.	17
Purolator Products, Inc.	13
Sharples Corp., The	21

CURRENT LITERATURE

A.P.I.—28th Annual Meeting, Chicago, Nov. 8-10, 1948 (Preprints of Papers)

LUBRICATING—OIL IMPROVERS
Boehm, A. B.—7 pages

This paper reviews the growth and present proportions of the lubricating-oil additive uses. Data on pour depressants are given. The mechanism of viscosity-index improvers is discussed, and data presented show the effect on winter motor oils. The reliability of 2-105B gear tests as criteria for passenger-car gear-oil performance is questioned. In the selection of motor-oil additives, the author predicts there will be more emphasis on deposit control and less on extremely low L-4 test bearing corrosion. Other reported trends in application of additives to improved lubricants, says the author, include aviation oil, torque converter oil, Diesel oil and industrial oils.

Chemical Engineering Progress, Vol. XLIV, No. 12, December, 1948

PHASE RELATIONS FOR PETROLEUM FRACTIONS
Edmister, W. C., and Pollock, D. H.—pp 905-926

The paper was presented at Seventh Regional Meeting, New Orleans, La. Phase conditions of petroleum fractions can be predicted by empirical correlations based on experimental equilibrium flash-vaporization data. In order to provide such experimental data twenty-seven typical refinery stocks were investigated. Twenty-one of these runs were made at atmospheric pressure only, while the remaining six were conducted at various pressures up to 200 pounds per square inch gage. ASTM distillations were obtained on the equilibrium vapor and liquid from the runs on nine stocks. In addition to these flash-vaporization data, true-boiling-point distillation data were procured for six of these stocks and for six additional stocks. Based on these new data, plus all data available from the literature, an improved empirical method of predicting the equilibrium flash-vaporization (E.F.V.) curves of petroleum fractions at various pressures has been developed. This method consists in: (a) a three-way correlation relating ASTM, T.B.P. (true boiling point) and atmospheric-pressure E.F.V. distillation curves, (b) a critical point correlation and (c) a correlation for the effect of pressure on the E.F.V. curve. An example of the application of this method in the design of distillation equipment is presented. Extensive tables are included.

PRINCIPLES OF EXTRACTIVE DISTILLATION
Scheibel, E. G.—pp. 927-931

The fundamental principles of extractive distillation are discussed and a method is presented for selecting a suitable solvent for extractive distillation. A simple method is also presented for estimating whether components form azeotropes together with a method for evaluating the relative effectiveness of different solvents in extractive distillation. An approximate method for the design of extractive distillation processes is also presented by which it is possible to show by quantitative calculations that vapor feed is always advantageous in the extractive distillation column and also to show quantitatively the effect of prefractionation of the feed and when this prefractionation is unnecessary.

The Chemist analyst, Vol. XXXVII, No. 4, December, 1948

REMOVAL OF FILMS OF SILICONE LUBRICANTS ON GLASS APPARATUS. USE OF SURFACE ACTIVE AGENTS ON GAS ANALYSIS APPARATUS
Roeben, F. J., and McNally, J. F.—p. 86

The Dow-Corning silicone stopcock grease has been found to be satisfactory for glass-to-glass operating parts. Removal of the silicone films has been accomplished effectively by the use of a few selected surface-active agents at room temperature without prolonged time of contact. In general, the oil-soluble agents were more efficient than the water-soluble or water-dispersible varieties. The most effective of the agents tried was found to be nonaethylene glycol rininoleate (Glyco Products Co., S 556), prepared in the laboratory as a 5% solution by volume in acetone. Clean glass surfaces were obtained in passing the solution over the affected parts, following with a wash of cleaning solution (concentrated H_2SO_4 and $K_2Cr_2O_7$ and a water rinse.

Chemistry & Industry, No. 1, January 1, 1949

FLUORINE CHEMISTRY
Anon.—p. 7

The development of the production, in Great Britain, of various fluorine compounds by the Imperial Chemical Industries, Ltd., is outlined. The production of fluorochloro refrigerants (Arcton 4 and Arcton 9), production of basic chemicals needed to develop new fluorine-containing products and to establish their manufacture, and production of fluorocarbons and fluorochlorocarbons are covered.

Corrosion, Vol. V, No. 1, January, 1949

WHAT TO LOOK FOR IN HYDRAULIC OILS. VII, Non-Corrosive Qualities (Concluded)
Zino, A. J., Jr—p 20
(American Machinist, Vol. XCII, Feb. 12, 1948, pp. 126-128)

The author discusses tests for determining non-corrosive qualities of hydraulic oils.

Diesel Power & Diesel Transportation, Vol. XXVI, No. 12, December, 1948

HEAVY DUTY LUBE OILS — HOW THEY WERE DEVELOPED
Moody, L. F., Jr., and Round, G. A.—pp. 68-74

It is today generally known in American automotive, petroleum and military circles that the lubrication requirements of the engines of practically all ground force equipment of the Allied Armies during the recent war were met satisfactorily by a single type of oil with only three viscosity grades to cover all climatic requirements. This was the dispersive-detergent, anti-oxidant, heavy-duty-type of oil, the oil which is now known as U. S. Army Specification 2-104B Oil Engine, used in but three viscosity grades, SAE 10, 30 and 50. The development of this oil, operating conditions involved, lubrication difficulties which had to be overcome, hard alloy bearing corosion, Diesel engine problem, testing of heavy-duty lubes, the results of the tests, and postwar developments of the oil covered.

Vol. XXVII, No. 1, January, 1949

NEW IMPROVED OILS COMBAT EFFECTS OF HIGH SULFUR FUELS
Anon.—pp. 48-52

Pointing out that high-sulfur Diesel fuel may be responsible for the ring sticking and corrosive wear, and for engine deposits, in general, the author recommends the use of superior lubricating oils with improved additives and detergent qualities. Three such oils are described including their characteristics, the results of the field tests, and their applications.

DUAL-FUEL ENGINES BY COOPER-BESSEMER
Anon.—pp. 56-58, 98

This is the second of a series of articles dealing with the subject of dual-fuel engines (See the Dec., 1948, issue of this magazine). In the present issue the dual-fuel engines built by the Cooper-Bessemer are discussed and the Type LS both naturally aspirated and turbocharged, is discussed as being typical of Cooper-Bessemer practice. Gas entrainment, control, economics and maintenance are covered.

Fuel, A Journal of Fuel Science, Vol. XXVIII, No. 1, January, 1949

THE INFLAMMABILITY OF OIL MISTS
Burgoyne, J. H., and Richardson, J. F.—pp. 2-6

A study has been made of inflammability characteristics of suspensions in air of mists derived from oils of low volatility, particulary cutting oils not of the 'soluble' type. The effect of incombustible liquids added to the oil drops was studied in mists mechanically formed at an air jet.

PRODUCTION OF ELECTRICITY FROM COAL BY ELECTRO-CHEMICAL MEANS
McKee, J. H., and Adams, A. M.—pp. 6-11

The historical development of the fuel cell is briefly reviewed. The types, construction, and practical considerations of cells are also given. Experiments to assess the endurance efficiency of a Baur type cell are reported. The production of electricity from fuels by electrochemical means remains worthy of consideration, but extensive experiments to develop a satisfactory cell are required. Fifty-one references are given.

The Institute Spokesman, Vol. XII, No. 9, December, 1948

MULTI-PURPOSE AUTOMOTIVE GREASE
Fraser, H. M., and Spooner, F. W.—pp. 8-13

Until recent years, it was necessary to use three or more of the different greases then available to lubricate effectively a car, truck or bus. Strontium, barium and lithium greases are new metal base greases developing during the war, due to stringent requirements. They combined high melting point, water resistance and good mechanical stability. The International Lubricant Corp. and Shell Oil Co. have developed a particular type of lithium grease having all the necessary properties. Four testing machines used were: 1. ILC Oscillating Friction Machine. 2. Shell Rolling Apparatus. 3.

(*Continued on page* 95)

NEW PRODUCTS and EQUIPMENT

NEW WICK OILER

Recommended for any equipment having solid bearings oiled from the top, where a *measured* quantity of *filtered* oil is desirable. Feed of oil is controlled by varying size of wick embodied in the tamper-proof base fitting. Greater feed variation can be obtained by using lighter or heavier oil. Will feed oil or liquids as thin as water or as heavy as molasses.

Crystal clear, shatter-proof plastic bottle keeps oil supply always visible. All metal parts heavily plated for corrosion resistance, easy cleaning. Large sediment chamber traps dust, dirt, chips, filings, etc.—wick completes filtering.

Available in 4 types—with or without sight-fitting—with or without feed shut-off—1, 2, 4, and 8 oz. capacities in each type. Five wicks, of graduated delivery capacity furnished with each oiler.

Made by TRICO FUSE MFG. CO., 2948 No. 5th Street, Milwaukee 12, Wis.

Complete descriptive folder available FREE.

DC ANTIFOAM A.—BOOKLET

This new pamphlet gives the physical properties of DC Antifoam A; describes several methods for using this silicone foam killer; and outlines a technique for comparing the efficiency of defoamers. Tables of relative costs indicate that DC Antifoam A is often cheaper to use than defoamers costing only a few cents a pound. Listed on one page of the pamphlet are some of the industries and processes in which DC Antifoam A is used to control foaming in both aqueous and non-aqueous systems. In industries as widely separated as food processing, metal working, and paint manufacturing this silicone defoamer is used to improve operations.

DC Antifoam A is generally effective in low concentrations ranging from 20 to 200 parts per million. In weak foamers as little as 1 part per million is required. Among the advantages reported are the elimination of flammable foams, saving of material formerly lost when foaming occurred, shortening of processing time, more efficient operation of equipment, and a higher quality product. The DC Antifoam A booklet is available from Dow Corning Corporation, Midland, Michigan.

ORIGINAL PRESS

A. E. Carpenter, president of E. F. Houghton & Co., Philadelphia, manufacturers of industrial oils, chemicals and leathers, points with pride to the press, on which the first HOUGHTON LINE was printed in 1908. Also admiring the original press is Ann Fitzpatrick, manager of circulation for the HOUGHTON LINE, the tenth oldest external industrial house publication in the country. The press shown turned out 2,500 copies 41 years ago. Today, presses covering an entire floor run off over 200,000 copies to take care of a world-wide circulation. The original press was shown at a recent open house at Houghton's Philadelphia offices, attended by more than 800 employees and their families.

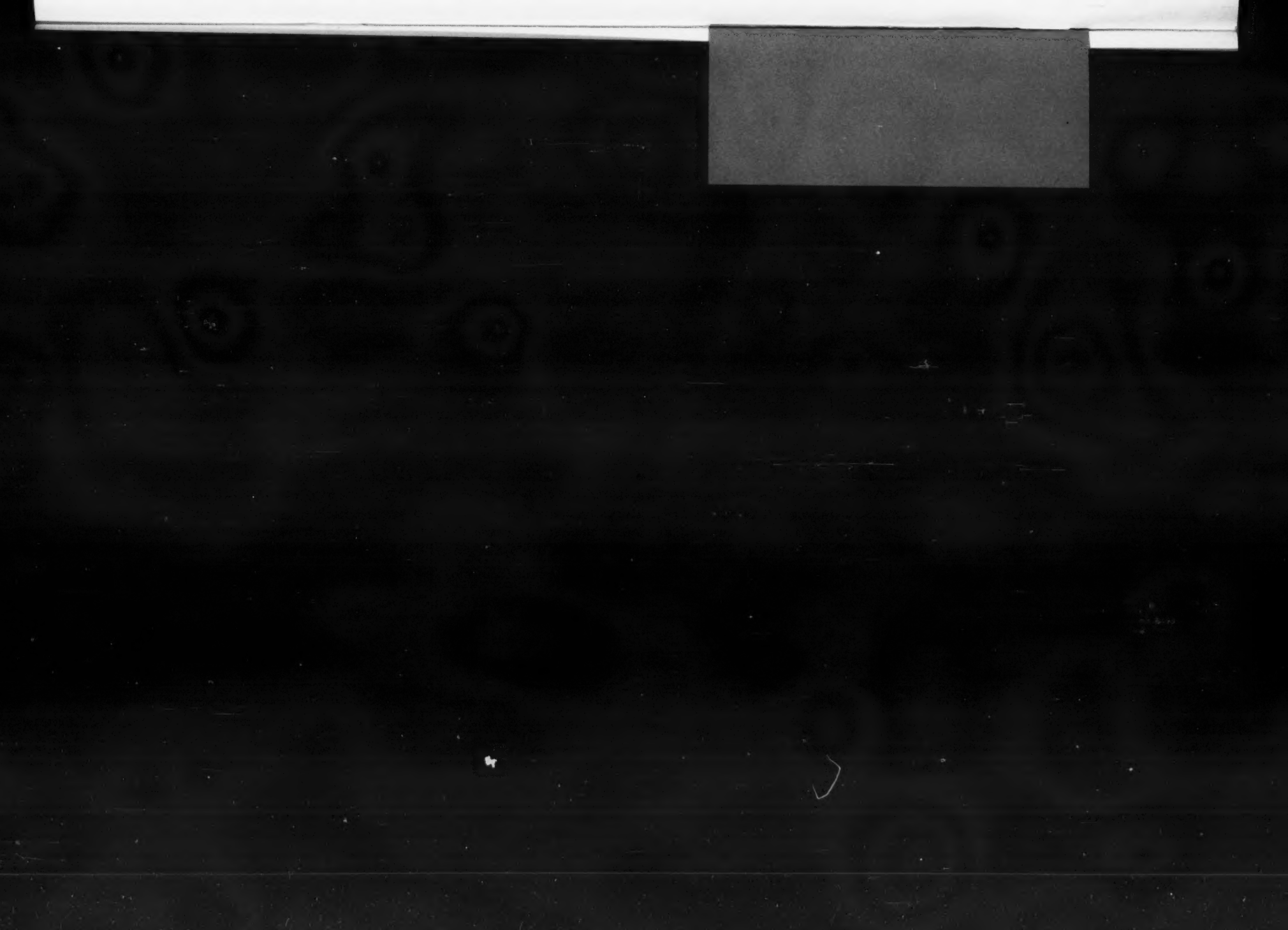
DRUMOBILE

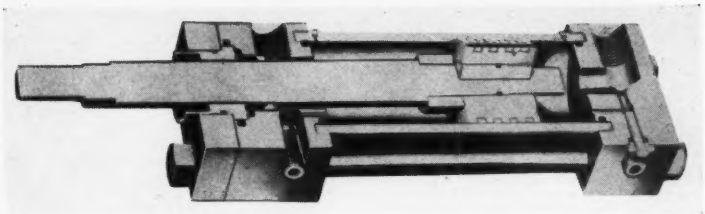
Eliminating manual exertion entirely from the handling of drums and barrels, an improved three-wheeled carrier is asserted to have likewise eliminated worker injuries such as backstrain, hernia, burns, crushed hands and feet.

The wheel-about implement, tradenamed Drumobile, and manufactured by Ernst Drumobile Division, Brantwood Products, Inc., Buffalo, N. Y., is specifically designed to lift, transport and release any size or type of steel drum, wood barrel or cylindrical fibre container. Model 800 Series now available is designed for loads up to 850 pounds in 50 to 60 gal. sizes. Concerns now using the prototype custom-assembled model are said to have effected not only an improved safety record but decreased labor and maintenance costs. Among such users are the most prominent petroleum, and edible oil producers, chemical plants, distilleries, food processors, bakeries, institutions, railroads and garages.

In maneuverability, the Ernst vehicle is said to have advantages intrinsic in its unique design. Scarcely wider than the drum itself, the Drumobile can be operated in close quarters where conventional carriers would generally be restricted. The lever-handle, after serving its function in lifting the load and actuating the safety lock, becomes a vertically free-swinging steering column adapting itself to any desired height.

Literature furnished by the manufacturer, Ernst Drumobile Division, Brantwood Products, Inc., 115 Brayton St., Buffalo 13, N. Y.





HYDRAULIC CYLINDERS

Substantial cash savings and the elimination of long waiting periods are a few of the advantages to cylinder users in the 10″ and 12″ bore, high pressure (2500-3500 psi) hydraulic cylinders now being offered in standard models at standard prices by Miller Motor Co. of Chicago, manufacturers of a complete line of air and hydraulic cylinders, accumulators, air hoists, boosters, counterbalance cylinders, and related products.

According to the manufacturer, this is the first time cylinders of this size and power have been put in volume production and offered in standard models for quick delivery. The new Miller 10″ and 12″ models are available in single and double rod end styles, and in a choice of piston and piston rod seals for different applications, including the automotive step-cut Miller piston ring piston seal and the leakproof, low friction Miller piston cup piston seal, which are interchangeable on the same piston rod. The cylinders conform to the J. I. C. Hydraulic Standards for Industrial Equipment and are of standard Miller design, with non-breakable solid steel heads, caps, and mountings, hard chrome plated piston rods, replaceable dirt wiper seals, and other features as described and illustrated in Miller Bulletin H-104. The cylinders are inspection-tested at 5000 psi. Parts are now carried in stock. For more information, write Miller Motor Company, 4027 N. Kedzie Avenue, Chicago 18, Ill.

NEW BIJUR BOOKLET

A new book entitled: How to design a lubricating system into the small machine. . . . . .

It shows how the small-scale Bijur system can be applied to solve the multiple oiling problems of small machines and isolated units of large machines.

This is the system that has been successfully used on many types of small machine ranging from zipper machines to radar equipment, from business machines to machine tool mechanisms, and from sewing machines to moving picture projectors.

Your attention is called particularly to the small-capacity lubricators pictured on the cover. Either automatic or one-shot, these units reliably provide minute quantities of oil at frequent intervals under conditions of either continuous or intermittent service.

Also of interest is the small-scale distribution system which is designed for a maximum of effectiveness within a minimum of space. Meter-Units for positive control of oil flow are smaller versions of the standard Bijur meter-unit, controlling oil feed down to a "fraction" of a drop.

Write for Bulletin 4C. Address: J. L. Parker, S's. Prom. Mgr. BIJUR LUBRICATING CORPORATION 43-01 22nd Street, Long Island City 1, N. Y.

"LUBEWAY"

A new dual-purpose oil is being introduced by Sun Oil Company for use in hydraulically operated machine tools that pressure-feed way lubricant from the hydraulic system.

This new lubricant, named "Lubeway," has already been subjected to more than a year's exhaustive testing in machine tool builders' laboratories and under regular production conditions in industry.

It had been found that ordinary hydraulic oils did not perform properly as way lubricants because they did not possess adequate film strength or metal-wetting qualities. This deficiency caused chattering of the table, excessive wear on the ways, and made close tolerances and fine finishes impossible.

Called in by a prominent machine tool manufacturer to overcome the problem, Sun engineers found the answer after extensive experimentation by blending some of the ingredients used in the manufacture of Sunoco Way Lubricant with Sun hydraulic oils which have been "job proved" for more than 25 years in industry.

After extensive tests in Sun laboratories and by machine tool builders, Lubeway was found to have all the stability and non-sludging characteristics of a good hydraulic oil, and also to possess the metal-wetting and extreme-pressure qualities of a good way lubricant.

All reports showed that Lubeway gave completely satisfactory service and did not form any gummy deposits in the pumps, lines, valves, or controls. It further proved its ability to protect ways and slides and assure their smooth operation.

For further information write: Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa.

"PRECISION" PENETROMETER

Precision Scientific Co., 3737 W. Cortland St., Chicago, announce the development of an improved penetrometer of wide application that will meet the most stringent penetration testing procedures. It tests bituminous materials, petrolatum, and greases in accordance with A.S.T.M. Methods D5, D217, and D937. In these tests a standard A.S.T.M. asphalt penetration needle, a Roberts No. 2 needle, or a standard A.S.T.M. grease penetration cone is used.

In the development of the penetrometer the advice of prominent scientists thoroughly familiar with penetration testing was sought and many of the suggested features were incorporated. Effort was made to embody features which would impart sensitivity and accuracy throughout a long operating life.

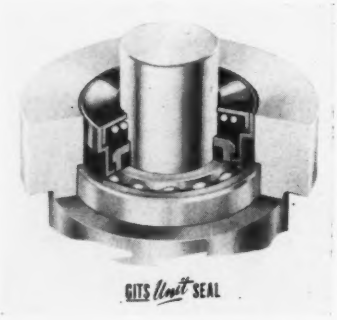
The Penetrometer has a 4-inch dial for easy reading in rapid routine work. The dial is divided in 380 tenth-millimeter subdivisions corresponding to 38 mm. penetration. On a full drop of the plunger the dial needle makes more than one complete revolution allowing direct penetration readings to 40 mm.

(The apparatus will be on exhibit April 11-13 at Booth 9, A.S.L.E. Convention.)

GITS UNIT SEAL

. A new "packaged" seal unit designed for horizontal and vertical rotating shafts has just been announced by a Chicago manufacturer. With both rotating and stationary surfaces built inside a metal cartridge, this seal permits a low-cost, fool-proof installation, according to the manufacturer, Gits Brothers Manufacturing Company.

This new seal, called the Gits Unit Seal, uses a radial seal joint, also known as face type or end type principle, which does not wear on the shaft, bearing race or any other parts in the machine or pump. The seal is factory assembled, and once the flat seal surfaces are placed in position they remain in perfect contact without warping.



Since the Gits Unit Seal is a complete seal in itself, there is no need for the user to prepare a hardened and lapped rotating seal surface of any kind, heretofore a considerable problem for most assemblers of original equipment. Seal faces are machine lapped uniformly flat to a definite specification, and they must pass a rigid flatness test designed to assure a leakproof seal joint prior to leaving the factory.

The major components of the Unit Seal are the stationary seal ring, diaphragm, spring assembly, and the rotating seal ring which is variable in shape according to the design requirements of the particular application. The time-proved principle of obtaining axial movement in the seal through the use of a free flexing diaphragm has been retained.

The stationary seal nose is permanently fastened to the inner edge of the synthetic rubber diaphragm, with the outer edge permanently fastened to the outer seal case. A positive leakproof flexible connection between the seal case and the seal nose thus is simply achieved. The spring in the Unit Seal is required only to keep the rotating and stationary seal surfaces in leakproof contact.

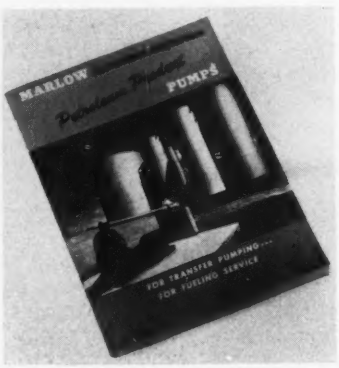
Copies of a colorful new bulletin describing the Gits Unit Seal, other information and prices may be obtained from the Seal Division, Gits Bros. Mfg. Co., 1846 South Kilbourn Avenue, Chicago 23, Illinois.

MARLOW PUMP BULLETIN

One of the significant events in petroleum products handling in recent years is the development of pumps that combine the efficiencies of centrifugal action with positive self-priming and self-purging action.

Now, for the first time, information developed about the use of this new kind of pump for petroleum handling, is presented by Marlow Pumps in a brochure just announced by this manufacturer.

Attractively prepared on twelve pages and in two colors, the new bulletin presents important calculation tables specially compiled by Marlow Pumps in its research and development work. They include a table of viscosities for different petroleum products with the viscosities shown at various temperatures. A table giving the head equivalents of various liquids and another of maximum practical suction lifts at various temperatures and from sea level to 2500 feet altitude.



In conjunction with this tabular information one page of the bulletin gives general information on pump installations and specific data on how to engineer an installation.

Several pages of the bulletin tell briefly about the Marlow Self-Priming Centrifugal Pumps used for pumping petroleum products. These are classified under two headings, engine driven models and electric motor driven models. The engine driven models are made in both high —and standard-pressure types, in sizes from 1½ to 6 inches, with capacities from 15 to 2000 GPM. Electric driven models are made in the same size range with motors from 1/3 to 40 horsepower, and capacities from 15 to 2000 GPM. A pump selection chart and specification table are shown for each category, engine and electric driven.

Other features of the pumps include a self-compensating shaft seal that is dripless and trouble-free and a design that enables the pumps to purge themselves so that they do not vapor lock. In a Marlow, the manufacturer states that the efficiency of the pump does not depend upon close tolerances. The impeller, mounted with free clearances, is practically unaffected by the abrasive action of tank scale, welding shot and other solids.

Copies of the new bulletin, PM48, are available free on request from the manufacturer, Marlow Pumps, Ridgewood, New Jersey.

NEW DIESEL LUBRICANT

A new diesel engine lubricant, designed to counteract the harmful effect of high sulfur fuels, has been developed by a manufacturer who specializes in heavy-duty lubrication problems—the D-A Lubricant Company, Inc., Indianapolis, Indiana.

The new product, D-A "Extra-Treated" Diesel Oil, is an additive-type lubricant designed for use in high-speed Diesel engines. Its development is based on results obtained from fullscale laboratory engine tests and field performance records.

Owners of certain type diesel engines operating on diesel fuels with a sulfur content in excess of 0.5 per cent have been confronted with the problem of engine sludge resulting in stuck rings plus a high rate of liner wear. The use of D-A "Extra-Treated" Diesel Oil will eliminate these sludging and wear conditions.

D-A engineers point out that new D-A "Extra-Treated" Diesel Oil is recommended only for use with high sulfur content diesel fuels. Regular D-A Diesel Oil is recommended for use under all ordinary conditions.

As oil wells go deeper and more foreign crude oil is imported, a greater percentage of diesel fuels will be marketed with a sulfur content above 0.5%. At present, high sulfur content fuels are being distributed in small quantities in various parts of the country.

D-A "Extra-Treated" Diesel Oil is available direct from D-A representatives or from equipment dealers all over the country.

(*Continued on page* 100)

NEWS OF THE SECTIONS

NEW YORK

Annual Convention: Final plans are almost completed for the annual convention to be held in New York City on April 11, 12, and 13. Particular emphasis is being placed on entertainment for ladies, since it is anticipated a large number of wives of members will attend. Several things of interest are being planned for each day so bring your wives. We guarantee them a wonderful visit in New York.

The New York Convention Committee, under the able Co-Chairmanship of C. M. Larson and E. M. May, announces a buffet supper and cocktail party on Sunday, April 10th, from 6:00 P.M. to 8:00 P.M. Fee —$3.50 per person. All members and guests are invited. Other entertainment being planned by the Committee includes a possible ocean-liner inspection, fashion show, radio broadcast and television. A Committee will be in attendance to give complete information on shows, dining spots, museums, art galleries, and other points of interest. Plans of the New York group will add much to the enjoyment of your stay in New York.

At the December dinner meeting, attended by a total of close to one hundred persons, Mr. James J. Scott of Bound Brook Oil-Less Bearing Co., presented a most interesting paper on "Oil-Retaining Porous Bronze Bearings."

Mr. J. C. Vangundy, secretary of the N. Y. section comments:

"Although the manufacture, physical properties and application of porous bronze bearings were covered by Mr Scott, the most interesting part of his paper dealt with the initial impregnation and re-lubrication of these bearings. When one considers that a bearing, such as used in automobiles, which is 1 inch in length, 1/2 inch in diameter, and with a 1/16 inch wall thickness will absorb only about ten drops of oil and that this oil must lubricate and not oxidize appreciably over long periods of time in the presence of copper, the importance of oxidation resistance of the oil is realized.

"Oils used for initial impregnation are highly resistant to oxidation as shown by the fact that when 125 ml. of oil is placed in a beaker with a group of porous bearings and held at 100°C. for 1000 hours, the neutralization number of the oil does not rise more than 0.1.

"Although more than twenty grades of oil may be used for initial impregnation depending on the use of the bearing, for general industrial applications an oil with a viscosity of 250-350 seconds, Saybolt Universal viscosity at 100°F. is employed.

"For re-lubrication of the latter, an oil of the same viscosity is employed. In addition, it should contain an oxidation inhibitor, preferably of the metal diactivating type. It should have a viscosity index of at least 95 and the base oil should be straight cut, rather than a blend to minimize light ends."

DAYTON

At the January meeting of the Dayton Section, Mr. George Gleim, Esso Standard Oil Co., New York City, spoke on "Lubrication of Machine Tools and Industrial Equipment." Mr. H. L. Seller's comments follow:

"Particular emphasis was placed on the matter of applying clean oil and grease to bearing surfaces. The matter of keeping oil in circulating systems clean, by use of filters, is very important. He pointed out that many large companies who are interested in protective maintenance are conducting schools for training their Oilers.

"The need for automatic lubrication devices was stressed, both from standpoint of economy in application as well as the assurance that equipment was being properly lubricated.

"It was his opinion that the consumers problems could be reduced if the machine tool manufacturers would simplify specifications on oils. Further, by cooperation within their own industry they could reduce the total number of lubricants needed for proper lubrication of machine tools. It is the job of Petroleum Industry to sell Lubrication, not Lubricants, thus reduce maintenance cost through protective maintenance."

PITTSBURGH

Mr. E. S. Reynolds, Secretary of the Pittsburgh Section, announces that at their February meeting, the speaker was Mr. Anthony J. Zino, Jr., Assistant Manager Industrial Sales, Swan-Finch Oil Corp. Mr. Zino's paper was entitled "What to Look for in Hydraulic Oils." The slides shown with the paper depicted the trend from early mechanically operated equipment to the modern streamlined machines, many of which are hydraulically operated. As a background for his discussions, cutaway slides were shown on various types of hydraulic pumps, such as the Vane type, Gear type, Radial Piston type, and Axial Piston type. It was explained how the various types of pumps required different types of petroleum product as the hydraulic fluid medium, and Mr. Zino emphasized the importance of piping valves, etc., on the viscosity of the hydraulic fluid medium. He pointed out that the usual physical specifications for hydraulic oils, such as Gravity, °API; Viscosity SSU; Viscosity Index; Flash Point °F; N. N.; Carbon Residue; Color, API, and Pour Point °F, do not always represent the desirable service properties of the fluid. Mr. Zino suggested that instead of the physical specifications, that "Service Properties," which would include Viscosity SSU; Viscosity Index; Demulsibility; Oxidation Stability; Lubricating Value; and Rust and Corrosion Preventive Qualities would give a better yardstick of the products under consideration. Mr. Zino's paper, along with the cuts, curves, etc., are to eventually appear in a printed booklet and should certainly be much in demand by engineers who work with hydraulic systems. The March meeting will be an inspection trip to the Gulf Research Laboratories. No meeting will be held in April due to the National Convention in New York. The May meeting will take place at Wheeling, W. Va., where a program is being arranged by Mr. Joseph Lykins.

(*Continued on page* 97)

Designing engineers prefer Timken Tapered Roller Bearings because they make machines perform better, last longer.

Lubrication engineers like Timken Bearings because they reduce lubrication problems to their simplest terms.

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Box 334

Significance of Tests and Specifications for Greases

(*Continued from page* 85)

give very little indication as to the performance of the grease. It has been assumed by some that a sodium soap grease is relatively fibrous and relatively water soluble or water emulsifiable. However, sodium soap greases can be made which are relatively resistant to water. In the past, it has also been generally assumed that sodium soap greases were relatively fibrous. Research during the past few years has resulted in sodium soap products of a smooth, buttery texture. As another case in point, calcium soap greases, commonly referred to as cup greases, are assumed to have low dropping points and low heat stability; that is, dropping points usually less than 220 F, and a tendency to decompose into soap and oil at temperatures of 160 to 170 F. Calcium soap greases have been developed and have been on the market for quite a few years which are heat resistant at temperatures much above the 160-170 F indicated above and do not break down into soap and oil even after heating to fluidity. It has also been assumed by some that a high free fatty acid content is undesirable, but there are good fatty acids and there are bad fatty acids, and merely knowing the value of the free fatty acid content will not necessarily give any indication of the performance of the grease. In the case of one bearing failure it was claimed that the grease was responsible. Although it was true that the grease had been highly oxidized, showing a high free fatty acid content because of the severity of the service, it was proved that the grease was not necessarily responsible for the failure by operating another bearing with the used grease for an extended period of time without obtaining any indication of bearing failure. In fact, performance of the latter was just about as good as with the fresh grease. The results from the analysis of a grease therefore are suitable for purposes of identification and to check uniformity, but they are no indication of performance value.

In the light of the above discussions, it can well be asked—what purpose do these tests on lubricating greases serve? It can be answered that they do have a definite value both to the manufacturer of greases and to the consumer of greases. But the test results are naturally of much greater significance to the manufacturer of the grease than to the consumer, simply because the manufacturer knows what went into the grease, how it was compounded, etc. It has been erroneously assumed that if a consumer of the grease can list sufficient test requirements, he can assure obtaining the product required for his types of service. This is not necessarily so since it is possible to meet test specifications and still have a product deficient in performance. The specifications on a grease mean more to the manufacturer simply because back of these specifications are much more detailed requirements which specify the types of raw materials to be used, the exact details of compounding these ingredients, etc. Back of the grease manufacturers' operations and specifications are thousands and thousands of hours of satisfactory performance. Millions and millions of pounds of grease have been sold and have been used in many different types of bearings and under many different conditions of operation with success. Therefore, it is much more important to know the proved history of performance of a grease rather than to know and specify certain test limits on it. The usual laboratory tests on greases can be used for identification purposes and as a check on uniformity by the manufacturer and the consumer, but cannot be used as a criterion of performance. Proved field performance is the best assurance for a satisfactory lubricant.

References

1) "Rationaiizing Lubricating Greases" by Martin B. Chittick. "The Institute Spokesman", Volume V, No. 3, June, 1941.
2) "Additives in Lubricating Greases" by Gus Kaufman, The Texas Company, Technical and Research Division, New York, N. Y. "Lubrication Engineering", May-June, 1947.
3) "Survey of Lubricating Grease Test Methods" by Carl W. Georgi, Chairman, Technical Committee, National Lubricating Grease Institute. "The Institute Spokesman", Volume VII, Nos. 5 and 6, August and September, 1943.
4) "ASTM Standards on Petroleum Products—Committee D-2". 1947. Page 605.

(*Continued from page* 89)

CRC Wheel Bearing Tester. 4. ASTM Mechanical Worker. Graphs IV and V illustrate the pumpability of the lithium multi-purpose grease.

EFFECT OF INORGANIC FILLERS IN GREASES ON WEAR OF ANTI-FRICTION BEARINGS

Georgi, C. W.—pp. 19-21, 23, 24

Practically all published recommendations for the grease lubrication of antifriction bearings specify the lubricant must contain no inorganic fillers and must have very low total non-oleaginous insoluble matter. Figure 1 is a cross section drawing of the wear test apparatus used. Figure 2 shows a typical group of wear test results. Figure 5 summarizes wear test results on a representative soda base bearing grease compounded with several different fillers as quite commonly used in grease formulations. Figure 6 summarizes tests on another group of fillers. Figure 7 summarizes tests on a series of metal salts, which are available in the form of finely divided powders and having in varying degrees a slippery or greasy feeling. Figure 8 lists test results on several lead compounds. The relation of particle size to potential abrasiveness is further illustrated in Figure 10, which summarizes tests on a variety of silica powders.

Journal of the American Chemical Society, Vol. LXX, No. 12, December, 1948

SYNTHESIS OF ALKOXYMETHYLTRIMETHYLSILANES

Speier, J. L.—pp. 4142-4143

KINETICS AND THERMODYNAMIC PROPERTIES OF THE DISPROPORTIONATION OF METHYLCHLOROSILANES

Zemany, P. D., and Price, F. P.,—pp. 4222-4226

First paper. The synthesis of three new ethers—methoxymethyl-, ethoxymethyl-, and butoxymethyl-trimethylsilanes—is reported, and the tendency of chloromethyltrimethylsilane to undergo hydrolytic cleavage under the influence of alcoholic sodium alkoxides was studied. Second paper. Equilibrium constants have been determined for the disproportionation of methylchlorosilanes at 350 and 420°C. Heats and entropies of the reactions were calculated. Rate measurements have been made on the reactions and a mechanism is proposed.

Journal of Industrial Hygiene and Toxicology, Vol. XXX, No. 6, November, 1948

TOXICOLOGICAL STUDIES ON CERTAIN COMMERCIAL SILICONES AND HYDROLYZABLE SILANE INTERMEDIATES

Rowe, V. K., Spencer, H. C., and Bass, S. L.—pp. 332-352

Toxicological studies with laboratory animals have shown that the silicones (methyl and mixed methyl and phenylpolysiloxanes) as a class are very low in toxicity and that they present no significant handling problems. Hydrolyzable silanes met with in silicone production are of two classes: chlorosilanes and ethoxysilanes. The former are highly corrosive and present serious handling hazards. The ethoxysilanes vary widely in toxicity. The methylated ethoxysilanes do not seem to present any serious handling problems.

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Journal of the Institute of Petroleum, Vol. XXXIV, No. 299, November, 1948

SPECIAL CHARACTERISTICS OF CENTRIFUGAL PUMPS FOR THE TRANSFER OF PRODUCTS OF VARYING VISCOSITY

Essman, I. G., and Gross, S. A.—p. 335A (Neft. Khoz., Vol. VI, 1948, pp. 51-55)

The use of centrifugal pumps on trunk pipelines for handling liquid of varying viscosity is discussed.

EXTRACTION AND DEWAXING OF LUBRICATING OILS

Ter Meulen, H.—p. 358A (Ingenieur, Vol. XXXVI, Sept. 3, 1948—pp. M43-M49)

The constituents of lubricating oils are indicated. The selection of a suitable extraction process and solvents used for dewaxing are taken up. A brief description of the methylethylketone benzol dewaxing process is given together with a description of the continous band filter.

PRODUCTION OF OLEFINS BY CATALYTIC CRACKING OF MINERAL OILS

Berti, V., Salvi, G., and Ghisoni, V.—pp. 358A-359A (Riv. Comb., Vol. 1, No. 3, 1947, pp. 129-148)

The effect of various catalysts in the cracking of mineral oils on the production of gaseous mixtures containing a greater proportion of olefins was studied. A further aim was to produce the greatest proportion of olefins higher than ethylene. The best results were obtained with aluminum and with silica-alumina mixtures.

WORKER-CONSISTOMETER FOR LUBRICATING GREASES

McKee, S. A., and White, H. S.—p. 362A (A.S.T.M. Bull., Vol. CLIII, Aug., 1948, pp. 90-98)

A new apparatus, developed at the National Bureau of Standards from the

(*Continued on page* 99)

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*Denotes Residence Address Preferred.

News of the Sections

(*Continued from page* 93)

FORT WAYNE

The two meetings held in the Fort Wayne Section this year consisted of excellent programs. Mr. Ed Freman, Chief Technical "Lube" Engineer of the Lubrite Div. of Socony-Vacuum Co. spoke in January on "Mysteries of Cutting Fluids" which was evocative of a fine discussion. In a lighter vein, the members were entertained by a coffee speaker in the person of Eugene Craig, cartoonist of the local newspaper, *News-Sentinel.* Mr. J. W. Thomas, Technical Representative of the Dow Corning Corp. was the speaker in February on "Silicones and Their Application as Synthetic Lubricants." The ensuing general comments dwelt on the commercial developments of Silicones with emphasis on oil and grease. An added attraction after dinner was the feats of magic by one of Fort Wayne's own members, Vernon Carr, lube engineer. The Fort Wayne group—one of our newer Sections—is making excellent progress with much enthusiasm demonstrated at their meetings.

BUFFALO

A recent meeting of this Section, reported on by Mr. Nathan C. Morrell, Secretary, consisted of an interesting and unusual program. Messrs. Pope and Critchlow reported on the recent A.S.T.M. meeting in Washington, D. C., covering activity in classification of oils, formation of new Committee on Gear Oils under Mr. Pope's Chairmanship, and testing of greases. A Board of Experts was named: T. A. Marshall, C. L. Pope, V. Steele, W. H. Parche, W. G. Peuchen, G. W. Miller, and A. M. Fowler. Several questions were propounded by the Chairman and others in attendance and the answers and discussion made a very excellent program. It was decided to conduct a Question and Answer period at each session, if time permits. "B-29's Over Dixie," motion picture film showing the erection of the Georgia plant of Bell Aircraft, the training of the personnel, and precision production of the great planes, proved a very interesting entertainment. The March meeting was held at the Rochester Institute of Technology in Rochester, N. Y. The dinner was followed with a short talk by Dr. Mark Ellingson, on the work being done at R.I.T. in their machine shop courses, which was followed by an inspection tour of the buildings and facilities. The Buffalo Section are sending a large delegation for attendance at the National Convention. The May meeting will be held in Canada, specific location to be determined by our Canadian members. In June, a social meeting will be held in or near Buffalo.

INDIANAPOLIS

On the evening of February 28th, the Indianapolis Section was addressed by Mr. F. M. Hewitt of Bijur Lubricating Corp. Mr. Hewitt makes his headquarters in Detroit. An interesting talk was given, accompanied by appropriate slides, showing various applications of Automatic Lubrication Systems, going into original factory installations. Mr. Hewitt's talk gradually turned into a general discussion which was very much enjoyed by those present. The technical session was followed by a business meeting. The National Secretary, W. F. Leonard, attended. The election of Officers will be held at the April meeting. Chairman Don Wilson reports much interest being shown in Indianapolis among industry in furthering of the science of lubrication.

DETROIT

Mr. James Hopkinson, Secretary of this Section, reports large and enthusiastic attendance at their monthly meetings. Mr. M. A. Hayden, Assistant Sales Manager of Vickers, Inc., delivered an informal talk recently before the Detroit group. Mr. Hayden's talk was considered very complete and much comment was made regarding its educational value. Mr. L. A. Danse of General Motors Corp., and one of our Directors, was present, and during the Question and Answer period, contributed many helpful suggestions.

MILWAUKEE

Mr. R. G. Clendenin of the Nox-Rust Chemical Corporation presented an illuminating talk on "Corrosion Prevention" at a recent meeting of this Section. This was followed by an interesting discussion.

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CHICAGO

For the third dinner meeting of the current year, the Chicago Section met at the Builders Club, 228 N. LaSalle Street on February 17. Following the dinner, Carl Schmitz, Chicago Chairman discussed the proposed course of action and also announced the results to date on the membership drive which is now in progress. Stress is being put on those industries which to date have not participated in the local section activities.

The speaker of the evening was Mr. Charles E. Pritchard of The Republic Steel Corporation whose presentation entitled "Industrial Lubrication" was exceptionally well received. This paper concerned itself with the various problems which confront the lubrication engineer in heavy industries such as in steel mills, etc., and indicated the types of lubricants and methods of application utilized in solving each problem. Specific examples were discussed and numerous slides were shown. The examples included outdoor cranes, bridges and unloaders, equipment operating under conditions of heat and water such as pig machines, etc., extremely hot equipment such as coke oven and furnace equipment, as well as heavily loaded mechanisms, high speed mills, and similar applications.

Methods utilized in reclaiming, blending and compounding as practiced in some industries were also reviewed, with slides showing the necessary types of equipment as well as the storage and handling facilities utilized for efficient operation.

It was announced that the next speaker would be Mr. Charles Pope of Eastman Kodak Co. Rochester, New York.

In attendance at the February meeting was one of our foreign subscribers, Mr. Lars Edman of Stockholm, Sweden. Mr. Edman has been a subscriber to LUBRICATION ENGINEERING for several years. He is at present residing in Chicago and is visiting and studying American procedures and methods at the Richfield Laboratories of the Pure Oil Company. Much of his work is being done with Harry Moir of Pure Oil. Mr. Edman is connected with the Swedish firm of A. B. Wahlen and Block of Stockholm who are petroleum refiners, compounders and distributors. The bulk of the petroleum needs of this firm are obtained from American petroleum exporters. Mr. Edman expects to remain in this country for an extended period visiting various lubricant suppliers.

We are indebted to Mr. Robert A. Kraus, Vice Chairman of the Chicago Section for this very complete report of the recent Section meeting.

BOSTON

Dr. Edgar S. Ross of the Sun Oil Company spoke recently at the Boston Section on "Refrigerator, Compressor, and Electric Motor Oils." Dr. Ross is widely known as an authority on lubricants and lubrication and has contributed much in the development of refrigeration oils. Following the dinner and prior to the main address, a short movie on "Birth of an Oil Field," produced by Shell Oil Company, was shown. Mr. R. B. Lewis, Secretary, reports that Mr. L. A. Danse, General Motors Corp., and a director of A.S.L.E., will address the March meeting.

CLEVELAND-YOUNGSTOWN

An interesting subject for discussion, entitled "Report on Present Ohio Legislation on Professional Engineering Practice," by Mr. John Finkelmann, was presented at a recent meeting. An additional feature was the presentation of a movie "Bearings by Graphite" which was a complete story of the manufacture of bearings. The commentator was Mr. Edwin Crankshaw.

NOTHERN CALIFORNIA

At the February meeting, new officers were elected for this Section, who will take over in March. (See Section Officers' page.) We are sure the new officers will continue the excellent work of the outgoing group. Professor L. M. Tichvinsky, University of California, gave a very interesting talk, illustrated by slides, on "Improvement of Heavy Duty Diesel Engine Bearings."

Current Literature

(*Continued from page* 95)

Hain microworker, is described which combines the processes of mechanically working the grease and measuring its flow characteristics in the same series of operations.

EFFECT OF DETERGENT ADDITIVES ON THE DISPERSING PROPERTIES OF OILS

Krein, S. E., Lipshtein, R. A., and Aleksandrov, A. N.—p. 364A
(Neft. Khoz., No. 6, 1948, pp. 43-50)

A test method has been developed for measuring the detergency (dispersive power) of an oil by determing the time required for the settling from the oil of a weighed amount (0.4%) of soot of constant mesh. The test is accelerated by centrifuging and heating the oil. A repeatability of 10-15% is obtained. Tests on seven oils show that whilst the dispersivity of an individual oil is a function of the viscosity it varies for different oils (tested at the same viscosity) and that the soot particles do not follow Stoke's law. Susceptibility of various oils differs to such an extent that an additive may increase the dispersity of one oil whilst lowering that of another.

THE LOAD-CARRYING CAPACITY OF THE OIL FILM BETWEEN GEAR TEETH

M'Ewen, E.—p. 365A
(Engineer, Vol. CLXXXVI, 1948 — pp. 234-235)

A mathematical proof is given that the load-carrying capacity of the oil film between gear teeth, neglecting end leakage, is directly proportional to their relative radius of curvature, not, as is usually stated, the square root of this quantity. The equation is presented.

Journal of Physical & Colloid Chemistry, Vol. LII, No. 9, December, 1948

THE EFFECT OF WATER AND OTHER ADDITIVES ON THE FIBER STRUCTURE OF CALCIUM SOAP GREASES

Birdsall, D. H., and Farrington, B. B.—pp. 1415-1423

The micrographs presented indicate that the fiber or crystalline structure in hydrated calcium soap greases disintegrates concurrently with the removal of water. The fiber disintegration leads in turn to the separation of soap and oil. Stearic acid and calcium acetate act as fiber builders in calcium soap greases but the fibers are radically different in size and shape from those in the hydrated grease. For effective structural stabilization calcium acetate or water must be present in molar concentrations approximately equal or greater than that of the soap.

Lubrication, Vol. XXXV, No. 1, January, 1949

STORAGE AND HANDLING OF LUBRICANTS

Anon.—pp. 1-12

The storage and handling of lubricants which are dealt with in this article involve a number of factors which should be considered. Storage facilities (construction features, proximity to points of delivery, bulk storage tanks, installation procedure, delivery, temperature control, and location of heating coils), handling equipment, storage of additive type lubricants, and storage of greases and gear lubricants are covered.

The Marathon Runner (The Ohio Oil Company, Inc.) Vol. XI, No. 1, Jan., 1949

LUBRICATION OF MECHANICS TYPE UNIVERSAL JOINTS

Anon.—pp. 6-7, 10

Universal joints in use on cars today may be divided into two classes—Detroit Ball and Trunion, and Mechanics' type. The lubrication of the Detroit Ball and Trunion type universal joint was described in the last published Marathon Service Series—No. 4, in The Marathon Runner of March, 1948. In the present issue the lubrication of the Mechanics' type is discussed, and illustrated in the accompanying "step-by-step" photographs.

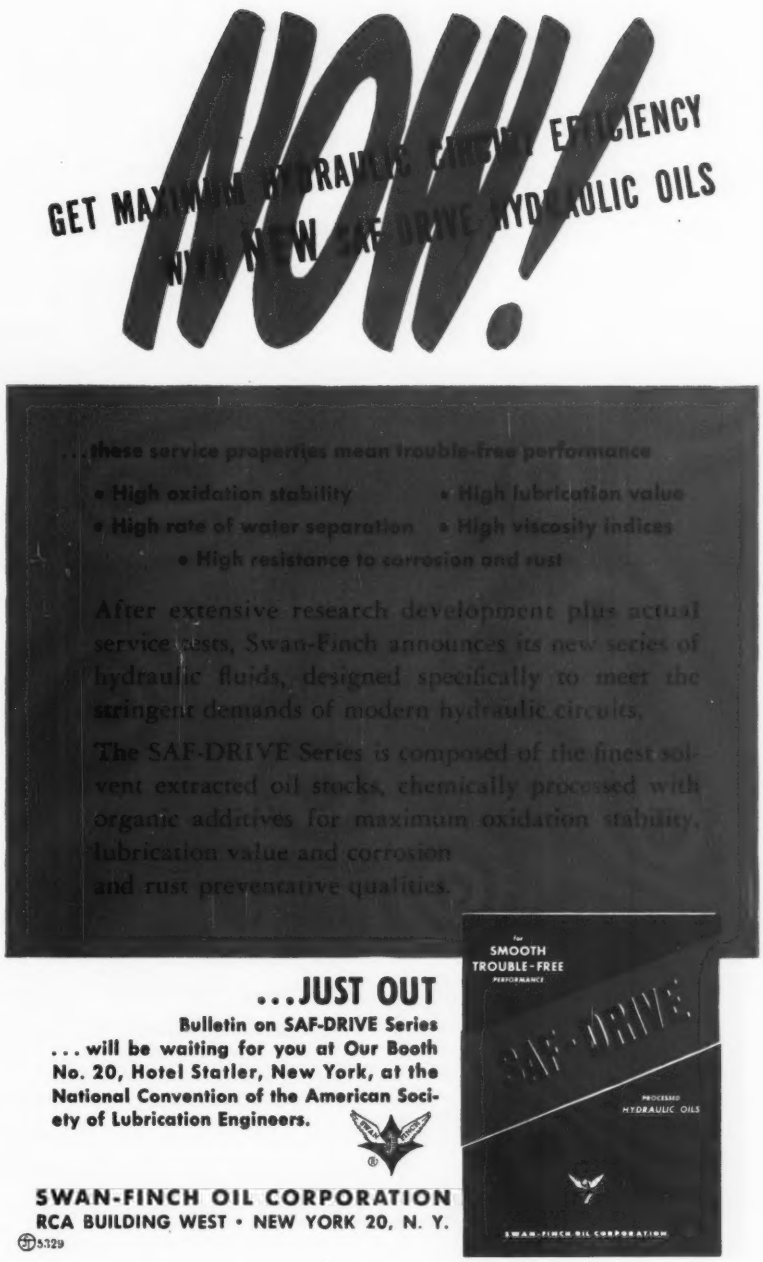
National Bureau of Standards Technical News Bulletin, Vol. XXXIII, No. 1, January, 1949

WORKER CONSISTOMETER FOR LUBRICATING GREASES

Anon.—pp. 10-12

Investigations of the effect of mechanical working on the physical properties of lubricating greases by S. A. McKee and H. S. White of the Bureau's lubrication laboratory have resulted in development of an apparatus that works the grease and measures its flow characteristics in the same series of operations. Principal advantages are its flexibility, wide range of shear and consistency measurements,

(*Continued on page* 107)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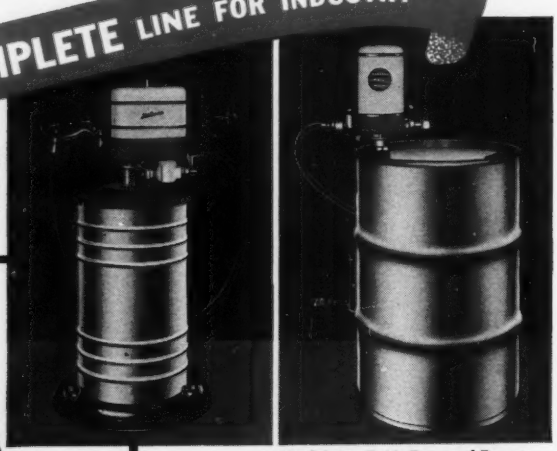

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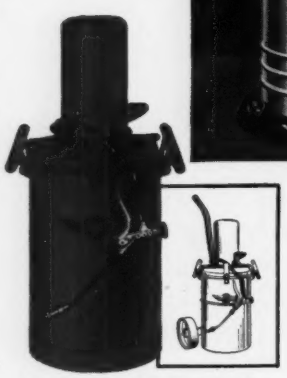

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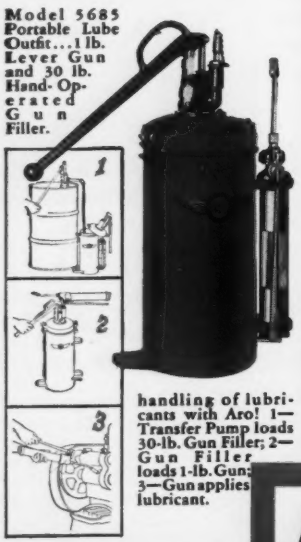

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(*Continued from page* 92)

LUBRICATION CONTROL

The Gerin Corporation of Red Bank, N. J., is distributing a new circular, No. 300, "Required Equipment for Lubrication Control." It illustrates the Portable Oil Inspection Kit recently announced by the company whereby any mechanic can quickly measure the contaminants occurring in lubricating oil during use. Simplified yet accurate methods are explained for measuring asphaltic and other deposit forming contaminants; dirt, metal particles, other sediment and water; acidity showing whether corrosion is possible and changes in viscosity due to fuel dilution and other causes. All four tests are said to be completed in 25 minutes for four samples of oil. The test for viscosity is especially interesting for its quickness and accuracy. "Required Equipment for Lubrication Control" is distributed free and available now.

HYDRAULIC SEALS

An 8-page, well illustrated reprint of "Hydraulic Seals" article in December Machine Design. It gives a sound, clear-cut, enlightening analysis of the advantages and disadvantages of the various types of "sliding type" hydraulic seals now in use, and stresses the important fact that fitted cylinder parts are frequently more responsible for seal failure than the seals themselves. The reprint discusses recently developed "leak-proof" seals, explains the cause of "chatter," and covers the general operating characteristics of metallic and non-metallic piston and piston rod seals, including synthetic rubber, piston cup, piston ring, flange, contracting ring, "O" ring, chevron, static and other type seals, and gives recommendations for their proper application. The size of the printed article, is 8½" x 11", saddle stitched. It is available at no obligation by writing Miller Motor Company, 4027 N. Kedzie Avenue, Chicago 18, Ill.

OILS AND LUBRICANTS PATENT ABSTRACTS

Mineral Castor Oil—Patent #2,458,034—Reuben A. Ewenson and Alfred W. Weitkamp, assignors to Std. Oil Company.

A mineral castor oil comprising a major proportion of a hydrocarbon oil, from about 0.5% to about 15% of an aluminum soap, from about 0.05% to about 5% of a polyhydric alcohol, and from about 0.005% to about 2% of a metal soap of a preferentially oil-soluble sulfonic acid.

Oil Compositions—Patent #2,458,425—Albert G. Rocchini, assignor to Gulf Research & Development Co.

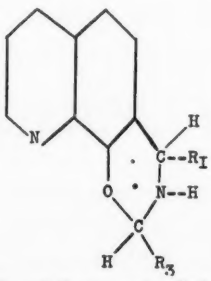
An oil composition consisting essentially of a major proportion of a mineral oil and a minor proportion sufficient to improve the detergent, anti-oxidant, and anti-corrosion characteristics of said mineral oil of an oil-soluble polyvalent metal salt of an alkenyl-succinic acid monoamide in which the alkenyl group contains from 5 to 18 carbon atoms.

Fusible and Readily Removable Protective Coating for Metal Articles, Comprising Ethyl Cellulose and Mineral Oil—Patent #2,458,486—Arthur E. Young, assignor to The Dow Chemical Co.

A fusible coating composition, free from volatile solvents, which is homogeneous in the molten state, and which congeals, when cooled to below 100°F. in contact with a metal surface, to form thereon a homogeneous, supple, and easily removable coating, substantially free from oily exudation, comprising as principal constituents: from 15 to 30 per cent of ethyl cellulose having an ethoxy content between 47 and 52 per cent; from 35 to 55 per cent of a mineral oil having a Saybolt viscosity between 700 and 800 at 100°F., and an aniline point less than 90°C.; from 7 to 30 per cent of a liquid condensate having a molecular weight between 300 and 600 obtained by heating a material selected from the group consisting of (1) styrene, (2) the mono-methyl homologs of styrene, and (3) mixture of the foregoing with a liquid monocyclic aromatic hydrocarbon from the group consisting of toluene and xylene, at a temperature between 50° and 150°C. in the presence of a condensation catalyst, and from 3 to 12 per cent of a hydroxylated fatty oil.

Mineral Oil Composition—Patent #2,458,526—Edward A. Oberright, assignor to Socony-Vacuum Oil Co., Inc.

An improved normally liquid hydrocarbon fraction selected from the group consisting of a normally liquid hydrocarbon fraction adapted for use as a fuel and a normally liquid hydrocarbon fraction adapted for use as a lubricant, said improved hydrocarbon fraction containing a minor proportion of a condensation product having the general formula:



wherein R_1 and R_2 are aryl radicals.

Mineral Oil Composition—Patent #2,458 527—Edward A. Oberright, assignor to Socony-Vacuum Oil Co., Inc.

An improved mineral oil containing a minor proportion of a material selected from the group consisting of an oil-soluble, nitrogen-containing condensation product and a polyvalent metal salt of said condensation product; said product being obtained by reaction of an aldehyde, a hydroxy-aromatic carboxylic acid and a polyamine in which each amino group has at least one hydrogen atom, at a temperature falling within the range varying between about 20°C. and the reflux temperature of the reaction mixture and for a time sufficient to effect the condensation reaction; the ratio of reactants used on the basis of one molar equivalent of the aldehyde being at least about one half molar equivalent of the polyamine and a sufficient amount of the hydroxy-aromatic carboxylic acid to provide about one molar equivalent of the hydroxyaromatic substitute thereof.

Printed copies of patents are available from the Patent Office at twenty-five cents each. Address the Commissioner of Patents, Washington, D. C., for copies and for general information concerning patents.

From Official Gazette—Vol. 618, Nos. 1, 2, 3, 4; Vol. 619, Nos. 1, 2, 3, 4.

Prepared by ANN BURCHICK

Mineral Oil Composition—Patent #2,459,112—Edward A. Oberright, assignor to Socony-Vacuum Oil Co., Inc.

An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25°C. to about 110°C., of an aldehyde, a hydroxyaromatic compound and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of hydroxyaromatic compound and at least about one fourth mol of polyamine.

Mineral Oil Composition—Patent #2,459,113—Edward A. Oberright, assignor to Socony-Vacuum Oil Co., Inc.

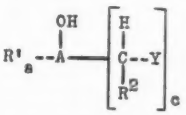
An improved mineral oil containing a minor proportion, sufficient to inhibit said oil against the deleterious effects of oxidation, of an oil-soluble, phosphorous—containing reaction product obtained by reacting one molar equivalent of an aldehyde with about one molar equivalent of a hydroxyaromatic compound and at least about one half molar equivalent of a polyamine in which each amino group has at least one hydrogen atom, in the presence of an inert diluent, at a temperature falling within the range varying between about 20°C. and the reflux temperature of the diluent and for a time sufficient to effect condensation, to produce a condensation product, and reacting said product with about one molar equivalent of a phosphorous compound selected from the group consisting of a phosphorous halide, a phosphorus thiohalide and a phosphorus sulfide, in the presence of an inert solvent, at a temperature falling within the range varying between about 20°C. and the reflux temperature of the inert solvent and for a time sufficient to effect phosphorization of said condensation product.

Mineral Oil Composition—Patent #2,459,114—Edward A. Oberright, assignor to Socony-Vacuum Oil Co., Inc.

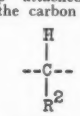
An improved mineral oil containing a minor proportion, sufficient to inhibit said oil against the deleterious effects of oxidation, of an oil-soluble, sulfur-containing reaction product obtained by reacting an aldehyde, a hydroxymatic compound and a polyamine in which each amino group has at least one hydrogen atom, in the ratio, on the basis of one molar equivalent of the aldehyde, of at least about one half molar equivalent to the polyamine and about one molar equivalent of the hydroxyaromatic compound, in the presence of an inert solvent, at a temperature falling within the range varying between about room temperature and the reflux temperature of the solvent and for a time sufficient to effect condensation, to produce a condensation product, and reacting said product with a sulfurizing material selected from the group consisting of elementary sulfur, a sulfur halide and a mixture thereof in the ratio corresponding to about one molar equivalent of aldehyde employed in producing said condensation product, in the presence of an inert diluent at a temperature falling within the range varying between about 20°C. and the reflux temperature of the inert diluent, and for a time sufficient to effect sulfurization of said condensation product.

Mineral Oil Composition—Patent #2,459,115—Edward A. Oberright, assignor to Socony-Vacuum Oil Co., Inc.

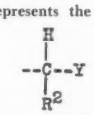
An improved mineral oil composition comprising a mineral oil having in admixture therewith a small proportion, sufficient to inhibit said oil against the deleterious effects of oxidation, of an oil-soluble phosphorus-containing reaction product obtained by reacting, at a temperature between about 20°C. and about 200°C., one mol of a phosphorus compound selected from the group consisting of a phosphorus halide, a phosphorus thiohalide and a phosphorus sulfide, with about 2.5 mols of a condensation product represented by the general formula:



wherein A is an aromatic nucleus; R′ is selected from the group consisting of hydrogen, alkyl, aralkyl, alkaryl, aryl, cycloalkyl, alkoxy and aroxy groups; a represents the number R′ groups attached to an aromatic nucleus A, and is an integer from 0 to 3; R^2 is selected from the group consisting of hydrogen, alkyl, alkaryl, aralkyl, cycloalkyl and aryl groups; Y is a morpholine group attached at the nitrogen atom thereof to the carbon atom of the



group; and c represents the number of



groups attached to aromatic nucleus A and is an integer from 1 to 3.

Method for Purifying Used Oils—Patent #2,459,409—Curt Roger Adolf Magnus Bjornstjerna, assignor to Aktiebolaget Separator.

A method for the continuous purification of used oil, which comprises pumping oil through an endless circuit and heating the oil in a heating locus during its passage through the circuit, continuously flowing oil to be purified from a source of supply into said circuit at a rate less than the rate of flow through the heating locus, continuously releasing a part of the oil flowing through said circuit while re-conveying through said circuit the part of the oil not so released, and purifying the released oil and returning it to the supply.

Continuous Method for Determining The Apparent Viscosity of a Grease—Patent #2,459,483—John C. Zimmer and Alan Beerbower, assignors to Standard Oil Development Co.

In a continuous grease manufacturing process, a method of continuously determining the apparent viscosity of a freshly prepared grease in a flowing stream which comprises passing a portion of the grease from said stream in streamline flow and under constant temperature and constant volume rate continuously through a flow retarding device of measurable length and radius, so that the rate of shear will be in the range of 10-1000 reciprocal seconds, and measuring the difference in pressure between two points spaced substantially apart along the flow-retarding device.

Organic Lubricant Composition—Patent #2,459,717—George L. Perry, assignor to Shell Development Co.

A composition comprising a major amount of a mineral oil, a minor amount sufficient to inhibit corrosion, of an alkyl dibasic aliphatic acid of at least 16 carbon atoms, and from about 0.01% to about 0.1% by weight of a sulfurized unsaturated fatty acid having at least 8 carbon atoms.

Lubricating Composition—Patent #2 459,718—Emmett R. Barnum and George L. Perry, assignors to Shell Development Co.

A mineral lubricating oil having incorporated therewith from 0.01% to 0.05% of sulfurized oleic acid having a sulfur content of from 12.4% to 25.8%.

Process of Producing Hydrocarbon Oil Concentrates of Metal Sulfonates—Patent #2.459,995—Gordon W. Duncan and John C. Zimmer, assignors to Standard Oil Development Co.

An improved method for producing concentrates of oil-soluble polyvalent metal sulfonates in liquid hydrocarbons which comprises contacting a petroleum oil solution of a material selected from the group consisting of preferentially oil-soluble sulfonic acids and metal salts thereof with an aqueous solution of a material selected from the group consisting of lead acetate, barium acetate, barium propionate

(*Continued on page* 107)

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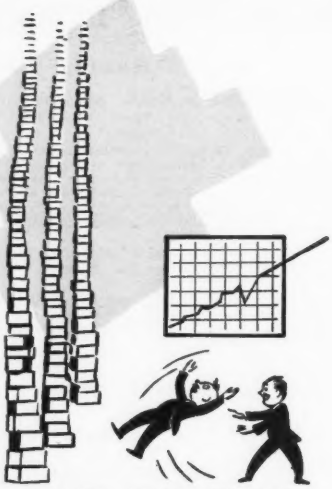

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(*Continued on page* 82)

tendency for f_s/f_k to decrease as the hardness or melting point of the metal combination increases. This behavior was previously pointed out in connection with Fig. 5.

It is apparent from Table I and Figs. 4 and 5 that an oiliness agent that is effective in reducing the friction coefficient for one combination of metals may be of little value for another. The importance of the composition of the surfaces as well as of the lubricant itself in boundary lubrication has been emphasized[11] before. Beeck, Givens, and Williams[12] have shown that the same statement also applies in the case of wear, although there apparently may be little or no relationship between the two phenomena in particular instances.

Summary

In spite of many variations and probable inconsistencies, the data shown in Table I and plotted in Figs. 4 and 5 show in a general manner the behavior of the static and kinetic coefficient of friction for surfaces dry and with three types of lubricant. As is to be expected, on the average both the static and kinetic friction are lower for the mineral oil than for the silicone, and are least of all for the oil with the additive. Almost without exception for dry surfaces, and in nearly all cases with mineral oil and the silicone, static friction is higher than kinetic. There is less difference, however, for lubrication with the additive and continuous sliding is more likely to occur. In general, the observations indicate that the stick-slip motion is uniform and regular for soft, low melting point, metals, particularly when dry. This is probably due to high adhesive forces at the metallic junctions and shearing within the metal itself. With hard metals point to point contact is the rule. Breaking at the junction and more irregular motion is the result.

The authors are indebted to Mr. A. J. Schieritz and Miss R. Morrison for assistance in taking data and to Dr. P. D. Foote, executive vice-president of the Gulf Research & Development Company, for permission to publish this paper.

Bibliography

1) W. E. Campbell, Trans. ASME *633,* Oct. (1939).
2) G. A. Tomlinson, Phil. Mag. *7,* 905 (1929).
3) W. G. Beare and F. P. Bowen, Phil. Trans. Roy. Soc. *234,* 329 (1935).
4) F. P. Bowden and L. Leben, Proc. Roy. Soc. A *169,* 371 (1939).
5) F. P. Bowden and T. P. Hughes, Proc. Roy. Soc. A *172,* 263 (1939).
6) H. Ernst and M. E. Merchant, Proc. Summer Conf. on Friction and Wear at M.I.T. (1940).
7) F. Morgan, M. Muskat and D. W. Reed, J. App. Phys. *12,* 743 (1941).
8) F. P. Bowden and D. Tabor, Proc. Roy. Soc. A *169,* 391 (1939).
9) J. B. Sampson, F. Morgan, D. W. Reed and M. Muskat, J. App. Phys. *14,* 689 (1943).
10) F. P. Bowden, A. J. W. Moore and D. Tabor, Jour. App. Phys. *14,* 8' (194b).
11) G. B. Karelitz, Proc. Summer Conf. on Friction and Surface Finish at M.I.T. (1940).
12) O. Beeck, . W. Givens, and E. C. Williams, Proc. Roy. Soc. A *177,* 103 (1941).

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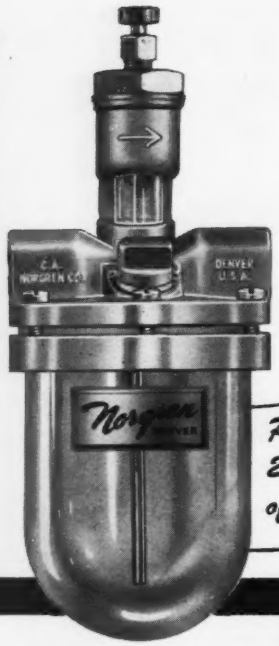

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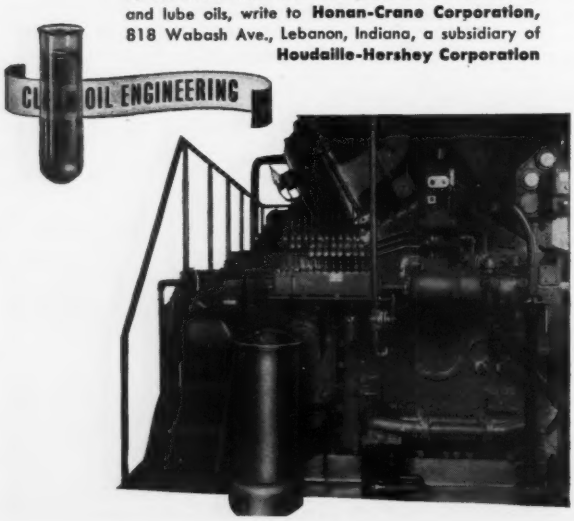

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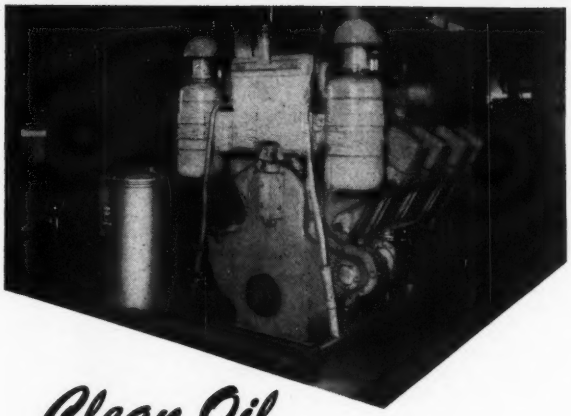

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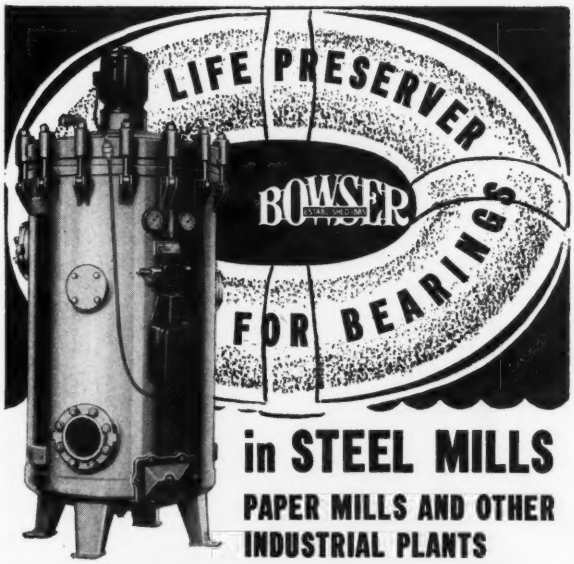

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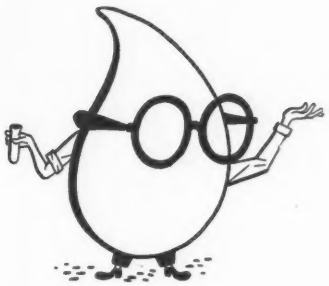

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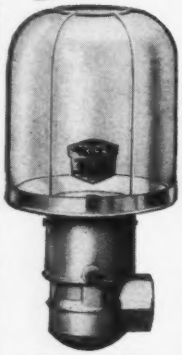

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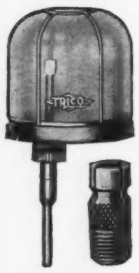

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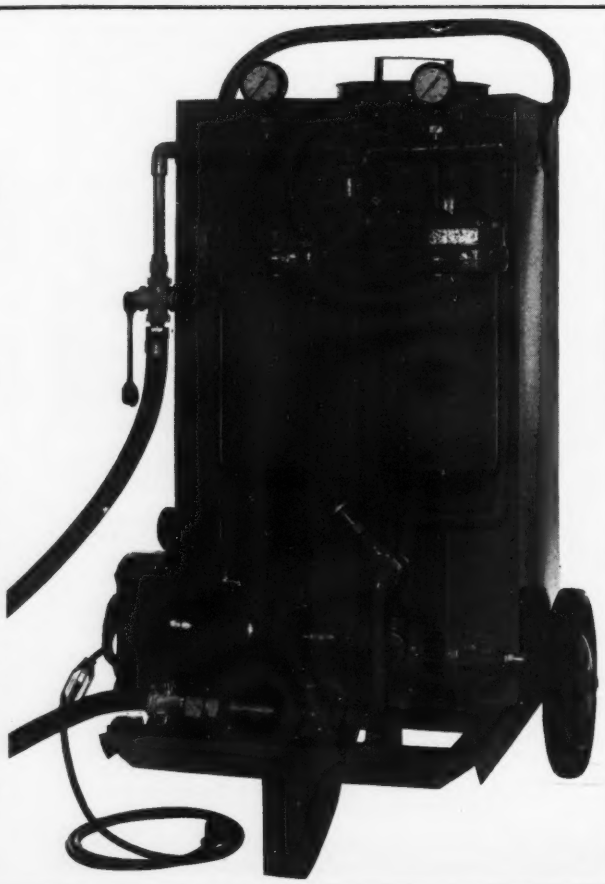

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and calcium propionate, heating the mixture to a temperature of 275-350°F. to effect dehydration of the mixture and precipitation of an oil-insoluble sulfonate complex; separating oil from the precipitated complex, reacting the separated complex with a dilute aqueous solution selected from the group consisting of hydrochloric acid and sulfuric acid, the polyvalent metal salts of which do not form oil-insoluble sulfonate complexes, to reconvert the oil-insoluble sulfonate complex to an oil-soluble sulfonate or sulfonate complex, and heating to dehydrate and remove volatile acids.

Lubricating Oil Composition—Patent #2,460,025—John G. McNab and Jeffrey H. Bartlett, assignors to Standard Oil Development Co.

A hydrocarbon material susceptible to deterioration by oxidation containing dissolved therein a small quantity, sufficient to stabilize said material against such oxidation, of a compound of the formula

$$RAr(XM)S_x(MX)ArR$$

in which Ar is an aromatic hydrocarbon nucleus, R is a branched chain aliphatic hydrocarbon radical containing 14 to 24 carbon atoms, X is a nonmetallic element of group VI of the periodic table, M is the hydrogen equivalent of a metal, S is sulfur, and x is an integer from 1 to 4.

Synthetic Lubricant—Patent #2,460,035—Dilworth T. Rogers and Jeffrey H. Bartlett, assignors to Standard Oil Development Co.

A normally liquid composition having lubricating properties, consisting essentially of a product of the polymerization of material having the structure—

$$ROOC{-}{-}CH{=}{=}{=}CH{-}{-}COOR'$$

where R and R' are straight chain alkyl groups, having not more than 10 carbon atoms each, and where the average chain length of the said groups in the unpolymerized material is from 3 to 10 carbon atoms.

Lubricating Oils—Patent #2,460,301—Bert H. Lincoln and Gordon D. Byrkit, assignors, by mesne assignments, to The Lubrizol Development Corp.

A lubricant comprising in combination a major proportion of an oil of lubricating viscosity and a minor proportion sufficient to stabilize the oil against oxidation of an oil-soluble halogen-containing organic phosphorus compound having the general formula R——N:P(Q)n where R is an organic radical containing a benzenoid ring structure; N is trivalent nitrogen; Q is a halogen radical, and n is a small whole number selected from the numerical group consisting of the numbers 1 and 3.

Spark Plug Thread Lubricant—Patent #2,460,632—Bert Folda, Jr., assignor to Socony-Vacuum Oil Co., Inc.

A spark plug thread lubricant comprising: 30 to 50 per cent by weight of a solid lubricant consisting predominantly of graphite, 0.5 to 5.0 per cent by weight an oil-soluble hydroxy heterocyclic amine the molecular weight of which is between 300 and 400, and the remainder a napthene-base lubricating oil.

Method of Dewaxing Oils—Patent #2.461.115—Curt Filip Holm and Bruno Kuno Engel, assignors to Aktiebolaget Separator-Nobel.

The process of dewaxing mineral oils which comprises chilling the wax-bearing oil in a plurality of stages in countercurrent heat-exchange relation to a flowing heat-absorbing liquid, separating from the chilled wax-bearing oil wax and substantially wax-free oil and utilizing the latter as a heat-absorbing liquid in all said stages, withdrawing wax-free oil from the heat-exchange system and separately cooling the wax-free oil so withdrawn and, at a point between two of said stages, mixing the so withdrawn and cooled wax-free oil with the wax-free oil flowing from the locus of separation.

Manufacture of Lubricating Oil—Patent #2,461,453—Fred C. Toettcher and John R. Coley, assignors to The Texas Co.

In the manufacture of turbine oils of superior emulsion resistant and oxidation stability properties the process that comprises first subjecting a lubricating distillate oil to treatments involving solvent refining and acid treating and neurtalizing to thereby produce a product having emulsion resistant properties adapted for turbine oil, and then contacting the solvent-refined and acid-treated and neutralized oil with activated clay in a quantity amounting to not less than about 10% by weight of the oil treated at a temperature of 650-750°F. with a contact time of about ½-1 hour to thereby effect reactions involving an increase in aromaticity and formation of structures which inhibit oxidation and causing increased oxidation stability without impairing the emulsion resistant property and produce a finished product having both the emulsion resistant and oxidation stability properties adapted for turbine oil.

Manufacture of Lubricating Oil—Patent #2,461,454—Fred C. Toettcher, assignor to The Texas Company.

The method of improving the oxidation stability of lubricating oil of the pale oil type that comprises separating from the lubricating oil a minor fraction constituting the higher boiling portion thereof, treating the minor fraction with activated clay at a temperature upwards of 600°F. and not in excess of about 750°F. with a reaction time of the order of ½-2 hours to thereby effect reactions involving an increase in aromaticity and formation of structures which inhibit oxidation, distilling off lower boiling constituents from the treated fraction to thereby concentrate the oxidation inhibiting constituents and blending the resultant stripped product with the untreated major portion of the lubricating oil to produce a blended product of increased oxidation stability.

Manufacture of Lubricating Oil—Patent #2,461,455—Fred C. Toettcher, assignor to The Texas Company.

In the manufacture of lubricating oil of superior oxidation stability the process that comprises subjecting a distillate lubricating oil to treatment with a solvent selected from the group consisting of acetone and furfural to thereby form a raffinate fraction and an extract fraction characterized in being more susceptible of improvement in oxidation stability by catalytic treatment than the raffinate, treating the extract fraction with activated clay at a temperature of upwards of 600°F. and not in excess of 750°F. with a contact time of the order of ½-2 hours to thereby effect conversion into constituents which inhibit oxidation and blending resultant products of conversion containing the inhibiting constituents with distillate lubricating oils to thereby increase the oxidation stability thereof.

Oil Base Drilling Fluid—Patent #2,461,483—Edward S. Self, assignor to Shell Development Co.

A non-aqueous drilling fluid comprising a mineral oil, a finely divided solid material suspended therein, and a stabilizing agent in an amount sufficient to prevent substantial separation of said solid material formed by the reaction of an alkali metal silicate with a soap forming fatty acid.

Lubricating Composition—Patent #2,461,961—John P. Buckman and Loren L. Neff, assignors to Union Oil Co. of California.

A lubricating composition consisting essentially of mineral lubricating oil and a small amount, sufficient to impart anti-corrosion properties to said oil, of an oil-soluble metal salt of an acidic reaction product obtained by reacting a lubricating oil fraction of petroleum with a compound of phosphorus of the class of phosphorus sulfides and phosphorus oxides at a temperature between about 200°F. and about 600°F. and reacting the product with an esterifying agent said small amount of said oil-soluble metal salt being sufficient to impart a phosphorus content of between about 0.01% and about 0.5% by weight.

Method of Preparing Lubricating Oils—Patent #2,462,360—Paul H. Carnell, assignor to Phillips Petroleum Co.

A method of preparing lubricating oil from an olefin polymer formed as a by-product in the treatment of a low boiling aliphatic olefin with hydrofluoric acid, said polymer when topped to 400°F. under a pressure of not over 10 mm. of mercury absolute having a viscosity of from 100 to 150 SUS at 100°F. and of from 20 to 50 SUS at 210°F., a viscosity index (Dean & Davis) of not over 20, which comprises treating said polymer with substantially anhydrous hydrofluoric acid in an amount such as to give a weight ratio of hydrofluoric acid to said polymer in excess of 1:1 but not over 10:1, at a temperature of from 75 to 100°C., and a pressure of from 100 to 250 pounds per square inch gauge for a period of time ranging from 20 to 140 minutes such as to produce a substantial improvement in the viscosity index and pour point of said polymer, and recovering the treated olefin polymer from the resulting reaction mixture.

Lubricating Oil Containing an Antioxidant—Patent #2,462,616—Lawrence T. Eby and Louis A. Mikeska, assignors to Std. Oil Development Co.

A composition of matter consisting essentially of a petroleum hydrocarbon product and an oxidation inhibiting proportion of a compound of the formula

$$(RAr)mHnBO_3$$

where Ar is an aryl nucleus, R represents at least one alkyl radical, the alkyl radicals containing a total of at least 16 carbon atoms, m is an integer from 1 to 3, n is 0, 1 or 2 and m+n equal 3.

short test cycle, simplicity of design, and, in particular, its provision for characteristic flow data while working under controlled conditions. In addition to the application to greases, Bureau engineers have used the apparatus to determine the apparent viscosity of rubber solutions at different rates of shear and temperature. The consistometer is composed of two coaxial steel cylinders mounted vertically with a capillary-type shearing element inserted between them. Close-fitting pistons force the grease through the shearing element in either direction from one cylinder to the other. While making flow measurements, dead weights are used on the down-stroke of the pistons and air pressure on the up-stroke. Provision is also made for automatic mechanical working. (Also described, in more detail, in A. S. T. M. Bull. 153, p. 90—Aug. 1948.)

National Petroleum News, Vol. XLI, No. 3, January 19, 1949

NEW CAR DESIGN LINKED TO FUTURE OIL PLANNING

Ridder, H.—pp. 18-21

Nine technical papers presented at the 1949 annual Society of Automotive Engineers convention cited current developments which can have important bearing on future planning in both marketing and refining. Five papers which report the progress of developments tending to increase mileage per gallon of gasoline for automobiles and trucks and discuss wiser utilization of energy sources and its effect on over-all petroleum supply and demand are reviewed.

VIEWS ON NATIONAL OIL POLICY STATED IN PETROLEUM COUNCIL REPORT TO KRUG

National Petroleum Council—pp. 38, 40-43

Partial text of the report on a "National Oil Policy for the United States" handed Interior Secretary Krug by the National Petroleum Council, is presented.

Oil and Gas Journal, Vol. XLVII, No. 33, December 16, 1948

GENERAL PLANT GREASES

Nelson, W. L.—p. 108

The general uses of greases are discussed in W. G. Forbes Lubrication of Industrial and Marine Machinery (John Wiley & Sons, Inc., New York). However, the material in Forbes is spread through many pages or chapters, and hence the recent article by H. A. McConville, Selection of Greases for General Plant Use (Plant Engineering, August, 1948, page 16) is suggested. Table 1 shows nine typical greases that will serve most of the needs of a manufacturing plant. They are the greases used in the Schenectady works of General Electric Company.

Vol. XLVII, No. 35, December 30, 1948

GLOBAL OIL RESERVES . . . A CURRENT REPORT . . .

DeGolyer, E.—pp. 144-146

The world's proved oil reserves as of the first of 1949 will be 78,322, or roughly 80 billion barrels. This oil is distributed approximately equally between the Eastern and Western Hemispheres. More than a third is in the United States and substantially more than a third in the Middle East. Data are tabulated by countries.

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Advertisers IN THIS ISSUE

Acheson Colloids Corp.	50
Alemite	60
American Cyanamid Co.	59
Aro Equipment Corp., The	100
Bijur Lubricating Corporation	54
Bowser, Inc.	105
Burns Laboratories, Inc.	108
Cincinnati Milling Machine Co.	52
Classified	94
Cuno Engineering Corp.	51
Dow Corning Corp.	61
Farval Corporation, The	Inside Back Cover
Fox River Tool Co., Inc.	106
Gits Bros. Mfg. Company	103
Grafo Colloids Corporation	98
Hodson Corporation, The	Back Cover
Honan-Crane Corp.	104-5
Houghton, E. F. & Co.	53
Lincoln Engineering Co.	56
Madison-Kipp Corporation	58
Manzel, Inc.	61
Morgan Construction Co.	62
Norgren, C. A., Co.	104
Oronite Chemical Company	95
Shell Oil Company, Inc.	102
Sinclair Refining Co.	104
Stuart, D. A., Oil Co., Ltd.	49
Sun Oil Company	55
Swan-Finch Oil Corporation	99
Texas Co., The	105
Tide Water Associated Oil Co.	57
Timken Roller Bearing Co., Inc.	94
Trabon Engineering Corporation	Inside Front Cover
Trico Fuse Mfg. Co.	106

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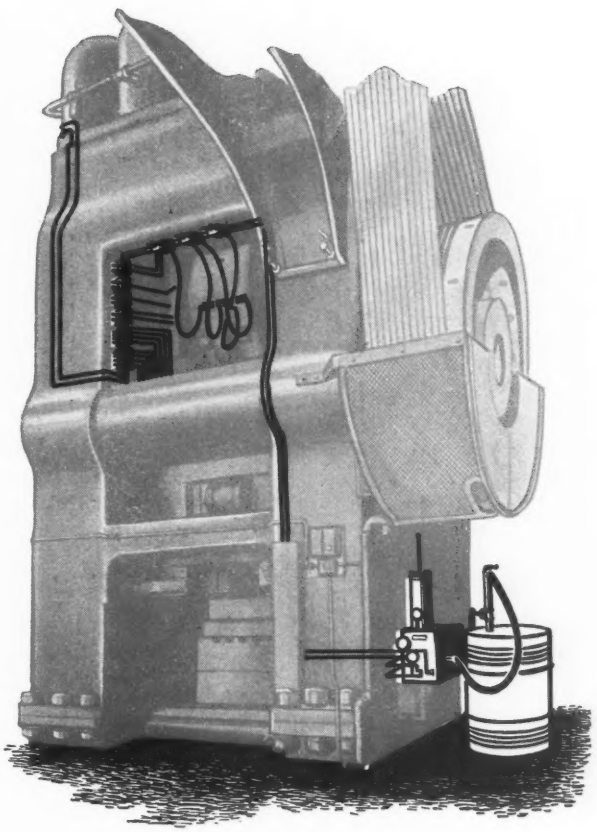

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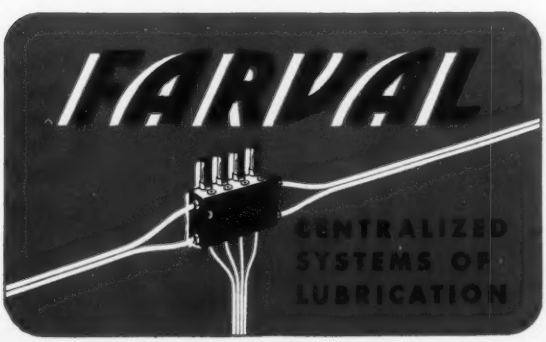

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